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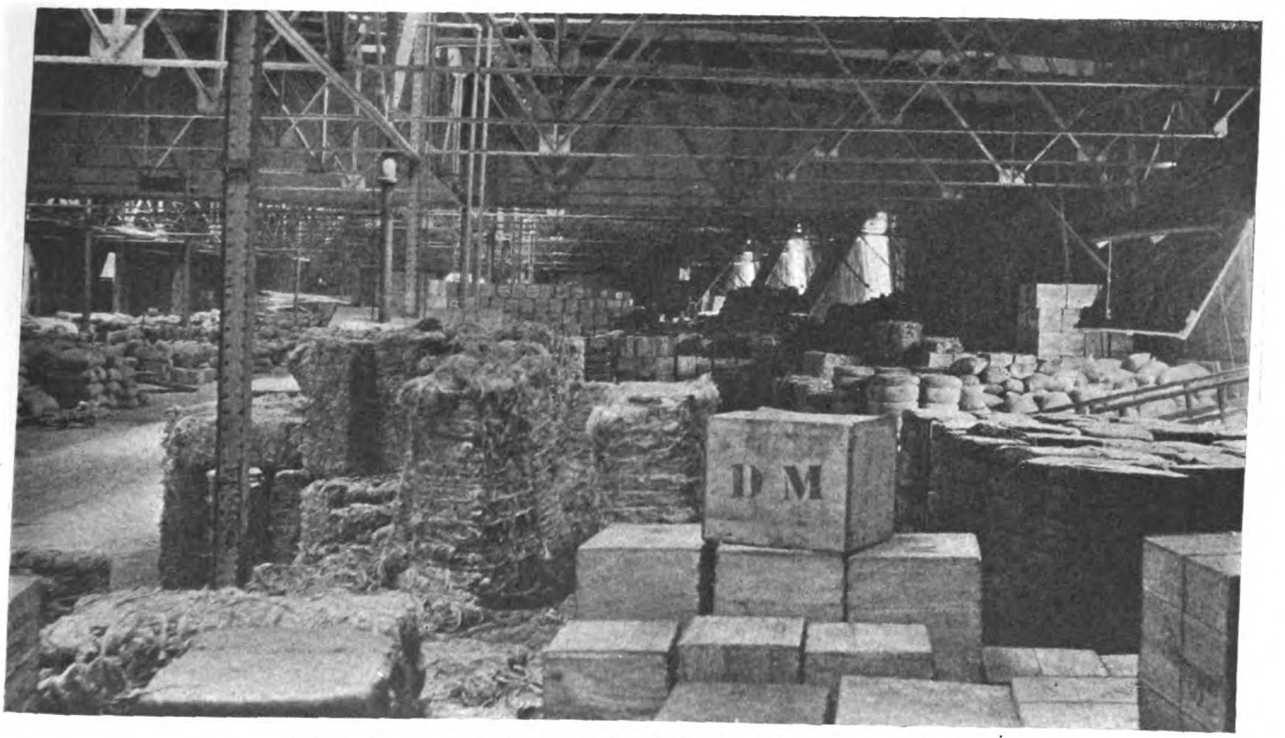

Fig. 1.—Pier Shed, Showing the Many Kinds of Freight to Be Handled

How Electricity Helps Solve the Package Freight Handling Problem

BY F. T. SMITH*

THERE is in every port, and especially New York, a great industry employing many thousands of men which has been carried on in almost the same manner for many years. Wherever terminals exist and ships discharge and load their cargoes of freight, the work is done largely by hand and at constantly increasing cost. Other industries of all kinds with foresight have adopted efficient automatic machinery and electricity as the motive power, with good profit and increasing production to the enterprising company making such advancement.

Freight is handled today at a great many of our seaport terminals in many respects similarly to the methods used several hundred years ago. In many places production and freight shipped have increased at least 100 percent. During the past twenty-five years railroad traffic has increased over four and one-half times as fast as the population. Due to the fact that very little improvement has been made either in rebuilding or using modern methods of construction or by installing mechanical methods of handling, also to lack of cars, fuel shortage and increased cost of labor, and very largely to the ever-increasing flow of package freight to the terminals, this point, the junction of rail and sea, has become the little neck of the hour glass.

The ultimate customer pays approximately one-third of the amount of his goods for transportation in one form or another. An analysis of transportation charges based on the average haul shows that about 50 percent of the freight charge is due to the high cost of handling in terminals. The average cost per ton mile for hauling package freight over 250 miles, the ordinary length of freight haul on railroads, is three mills, or a total cost to the customer for 250 miles per ton of $0.75.

Let us compare this with results obtained at the terminals.

The average shipment goes through at least two terminals, and often one or more transfer terminals as well. The different classes of freight and constantly varying

* Power and Mining Department of the General Electric Company.

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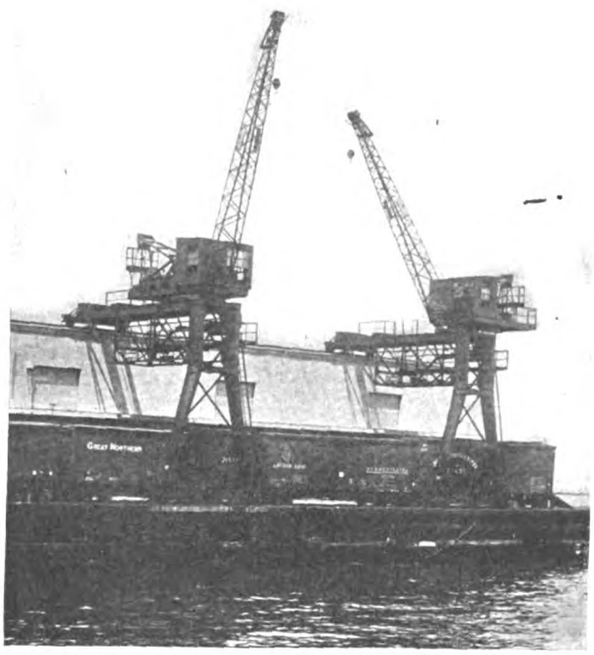

Fig. 2.—Semi-Portal Cranes and Double-Deck Pier

conditions make the cost per ton for handling hard to determine, but from available figures a safe average would be about $0.40 per ton per terminal, not including interest, depreciation and fixed charges on the terminal.

In the two terminals the cost of handling will be $0.80, or approximately 50 percent of the total cost of moving the ton of freight from the first delivery at one freight house to its departure from the terminal. More marked is the contrast at sea, for most authorities agree that ocean traffic costs only from one-sixth to one-tenth that of rail haulage.

New Electrical Devices Being Developed

No great systems for completely handling miscellaneous package freight have been developed, but the many electrically operated devices which are used as an aid are gradually developing themselves into a more complete system. Manufacturers of freight handling machinery are organizing in order that new apparatus may be developed, the present type used to best advantage and to promote a closer co-operation between the manufacturer and user. Recently, however, considerable attention has been given the package freight handling field. An example of this is shown in the piers and warehouses and seaport terminals built by the United States Quartermaster's Corps, and which are equipped with modern devices for saving labor in handling package freight.

The big problem, then, is to reduce the cost and time for handling at our terminals: to devise new ingenious machines and methods, and to make more economical and practical use of apparatus available for doing this work quicker and cheaper; to make labor better satisfied, and to reduce to a minimum the "turn around" of a ship in port and limit the possibilities of demurrage charges on railroad cars.

Electricity will play an important part in solving this problem. Central station electric power is available in all port cities and is sufficiently reliable to meet the requirements demanded of it by dock and terminal machinery. One type of machinery will not fit all conditions, due to a variety of freight and local conditions. Let us consider, however, the apparatus that is applicable to this work and how it may be used to advantage.

Cranes to Play Important Part in Future

Bridge cranes are so little used in package freight they will not be considered. Gantry cranes are common in railroad yards for serving gondola and flat cars, drays and temporary storage piles. A common span is 50 feet and the capacity runs from 25 to 100 tons. On the larger sizes there are usually four motors used, that is, main hoist, auxiliary hoist, bridge motion and trolley motion. They are equipped with alternating current (wound rotor motors) or direct current (series wound). Drum controllers are used in both cases.

Half-gantry, semi-portal or whirler cranes of 3 to 5 tons capacity span one and preferably two railroad tracks and are very serviceable for loading or discharging cargo from ships. One leg of the gantry runs on a track, while the other end of the crane travels along the edge of the pier shed.

The carriage with its whirler top permits the load to be taken from the hold of ship, swung and dropped into a car or at the side door of the pier shed. A modification of this would be the use of a straight track and carriage running out over the ship. This might be faster than the whirler type.

Locomotive cranes have the particular advantage of being ready at a moment's notice day or night. The number of motors required varies from one to five as a maximum. The power is obtained by means of a wooden-covered third rail alongside the track on which the crane is to work.

For cranes of any type where the hoisting speed is as high as 300 feet per minute, direct current is much the better proposition from the standpoint of operation on the machinery and life of the apparatus. However, for rope speeds of 150 or 200 feet per minute a very satisfactory alternating current arrangement using the solenoid load brake can be used. It is, however, somewhat more complicated to transmit three-phase current to an overhead structure by means of trolley wires than it is direct current.

Fixed and Portable Dock Hoists

It is interesting to note that a number of electric winches are being installed at several of the seaport terminals. A relatively small number of portable dock hoists rather than a large number of fixed ones has many advantages. They are made in single and double drum types with gypsy

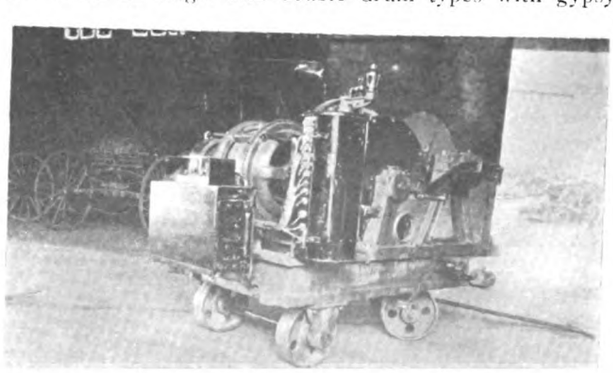

Fig. 3.—Portable Dock Winch with A. C. Motor and Controller

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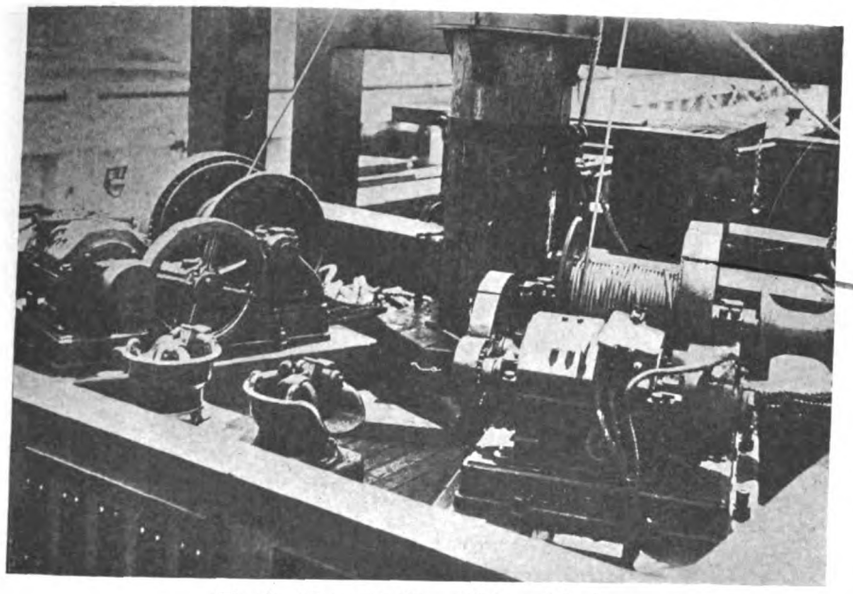

Fig. 4.—Electrically Operated Cargo Winch

heads and one or two motor drives. The winches are of about 2,500 pounds capacity and with a rope speed of 225 feet per minute and having either a 15-horsepower to 25-horsepower alternating current or direct current motor with solenoid brake or friction clutch and foot brake.

The control may consist of drum type controllers mounted on the machine or the magnetic control where the panel is mounted on the machine and the master controller is carried by the operator. The portable master controller when used with electric fixed or portable dock winches or with electric ship winches gives the operator a range of 100 feet radius or more if necessary and gives perfect control of both drums and the advantages of always having the load being hoisted or lowered in sight and insures quicker loading and unloading.

Briefly stated, the plan on which piers are being equipped is one of the following:

First, a sufficient number of portable two-motor, two-drum winches, with a double portable master controller strapped to the operator, who controls all movements from the ship's decks, are installed. The portable master is equipped with a broomstick support, which eliminates considerable strain from the operator in supporting the controller.

Second, a sufficient number of portable single-drum, single-motor winches, each controlled by a portable controller, is installed on the wharves.

At times when it is desired to use a single winch it may be controlled by a single portable master controller. The change from double portable master to single portable master can be easily and quickly made by means of transferring electric cables and plug connection boards.

In the near future electricity will be used more and more for electric winches for cargo handling on these cargo ships.

Of the many advantages of the electric ships' cargo winches over the steam winch, a few may be noted as follows: Clearer decks, greater ease and convenience of operation, greater certainty and dispatch in handling, no trouble from freezing up in cold weather.

The possibilities of the electrical industrial truck or "electric stevedore" have greatly increased since its introduction into the freight handling field. Trucks are usually rated at 2 tons capacity and work to best advantage on packages that can be readily handled by one or two men. They are tireless freight movers and the proper use of each type depends, of course, on lengths of haul, class of commodity, etc. Roughly, about half a mile out and return is the most economical distance per haul to operate an electric truck. When properly applied, they are able to cut the cost of moving freight to a marked degree. The motor used is enclosed, series wound, with a high starting torque, low current consumption and a very large overload capacity and designed to give the best results with the lowest possible drag on the batteries. The industrial truck is rugged and reliable in construction, simple in operation, and the flexibility of its movements gives it a big advantage over the machine limited to tracks. Of the many types, the following have been used with gratifying success in many places.

The load carrying type, where freight and material are carried on the platform of the truck, is especially adapted to work where trucks must be driven, loaded and unloaded by the same man, or wherever material is to be moved between widely separated locations in such quantities that it would not pay to have gangs of men to load and unload them. The load carrying truck serves best when hauling is restricted to narrow aisles and loading platforms, and where a destination is on a thickly congested floor where speed is of greater importance than tonnage.

Industrial Trucks and Tractors

The drop frame type is best adapted to carry heavy packages and pieces from 150 to 200 pounds, such as barrels, bales, heavy crates, etc. The greater the weight of separate pieces to be loaded, the lower the platform should be. It has been repeatedly demonstrated that after piling to a certain height it is false economy to require lifts that waste men's energy. As a rule, packages and pieces weighing 150 to 200 pounds can seldom be lifted higher than the knee; 75 to 100 pounds waist high, and

Fig. 5.—Load-Carrying Type of Truck Best Adapted to Narrow and Congested Aisles and for Use Between Scattered Locations

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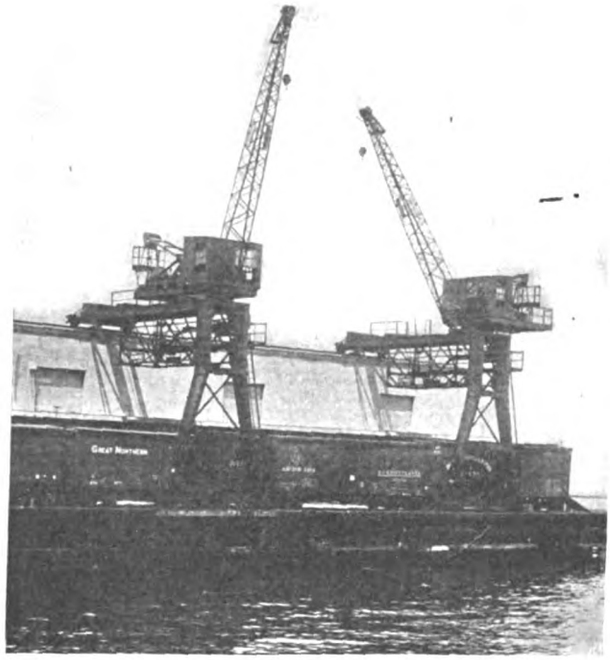

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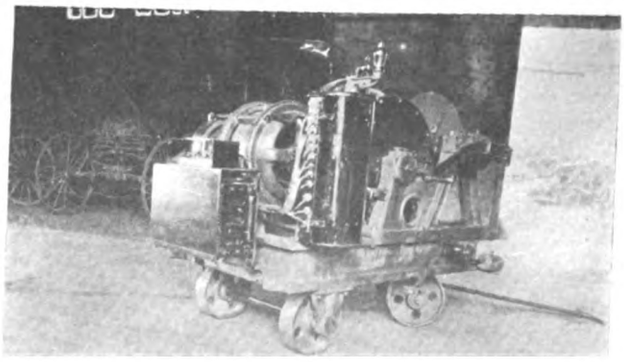

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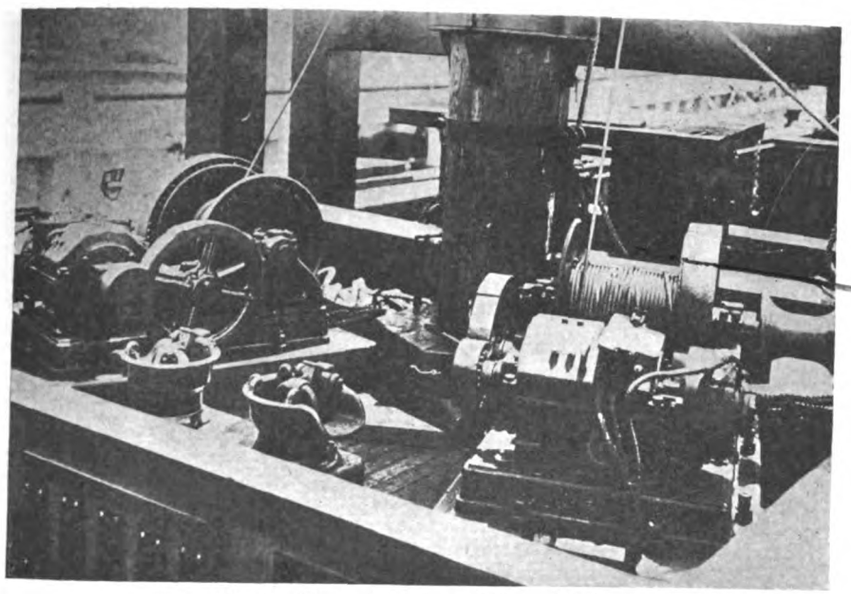

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Fig. 6.—Elevating Platform Type Truck Having a Movable Platform the Height of Which Is Regulated to the Kind and Size of Load

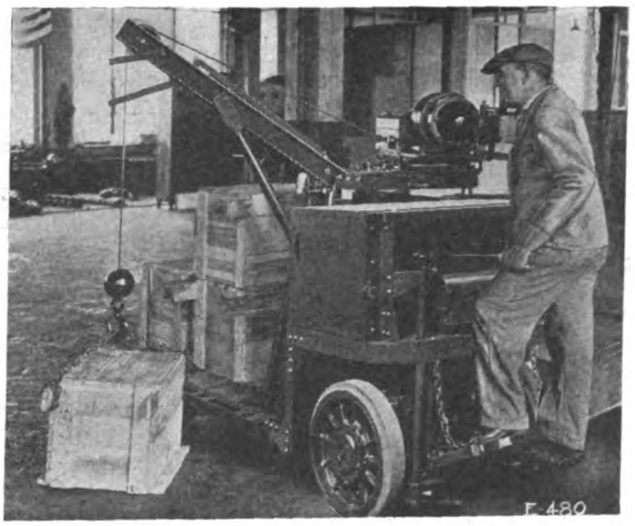

Fig. 8.—Crane Installed on Load-Carrying or Drop Frame Type Truck

25 to 35 pounds shoulder high. The heights are being decreased year by year.

The elevating platform type, similar to the drop frame type, has a movable platform which can be raised or lowered by a separate electric motor. These trucks are used for picking up, carrying and depositing loaded or empty skids or wooden platforms which can then be carried from place to place at the will of the operator. This method of freight handling is very effective, and surprising results have been obtained. The material placed on the skid or wooden platform is ready to be moved at a moment's notice; it can be vertically piled, by use of the electric piler described in a later paragraph, thus saving time and extra handling.

The baggage type is similar to the load carrying truck, or a combination of the load and drop frame types. This type is best adapted to carrying bags, trunks and mail pouches.

The crane type has an electrically operated crane of 1,000 to 4,000 pounds capacity, mounted temporarily or permanently on the load carrying or drop frame type. This type is especially adapted to handling heavy weights when the truck must move but short distances.

Another of similar type is the battery truck crane, which is larger and heavier and has a higher boom and longer outreach. This type has many applications in railroad freight terminals and piers and warehouses at marine terminals.

Tractors and Trailers Used to Advantage

The tractor truck is an economical self-contained power unit with a heavy draw-bar pull which carries no load, but pushes or pulls its load on trailer trucks. These trailer trucks are furnished with ball bearing front caster wheels which cause the trailers to follow very closely the tractor and give almost perfect tracking.

The tractor and trailer should have an important place in the modern terminal, the possibility of using three strings of trailers—one at the pile, one at the ship's side and one on the move—means less time lost and more material moved. It works to advantage where goods must be sorted in small unit loads and can be collected at one spot, then coupled in trains to be delivered to a single point or distributed. They will pull a trailing load of 50 pounds per pound of draw-bar pull and trailing loads of from 7,000 to 20,000 pounds, maintaining a speed of 4 to 5 miles per hour. A man with a hand truck, mule work, maintains a speed of less than 2 miles per hour with a load of 500 to 700 pounds. The saving in man power is evident.

Several successful installations of this method of freight handling have been made at railroad transfer stations.

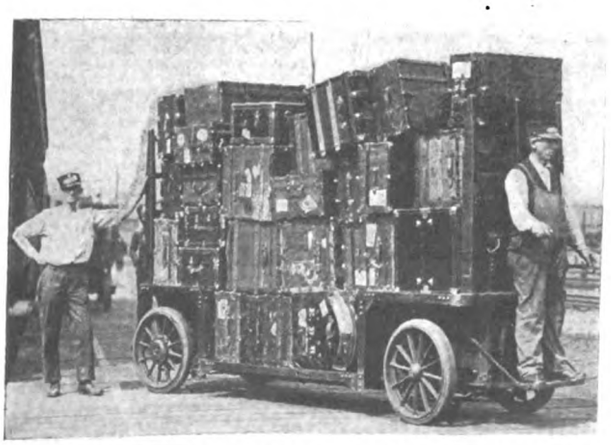

Fig. 7.—Bags, Trunks and Mail Pouches Are Easily Handled by the Baggage Type Truck

Fig. 9.—Discharging Coffee by Portable Conveyor from Ship to Wharf Shed, a Distance of 100 Feet

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Fig. 10.—Tractor Trains in Various Combinations Have a Hauling Capacity of from 7,000 to 20,000 Pounds

BATTERIES AND BATTERY CHARGING

The batteries may be either the lead Exide Iron Clad or the Edison, either one of which is in common use. The general characteristics of the two types are similar, but differ widely in specific points. Each has advantages that best adapt it to a particular installation.

Direct current is used for charging. If direct current is the supply it is furnished at the right voltage, either through a battery charging resistor or by a two-unit balancer set. If the source of supply is alternating current the mercury arc rectifier, motor generator set or rotary converter may be used to convert the alternating to direct.

The charging station should be so located that a truck or tractor will never have to travel more than 1,000 or 1,500 feet from the center of the area in which it operates to the place where it is to be charged.

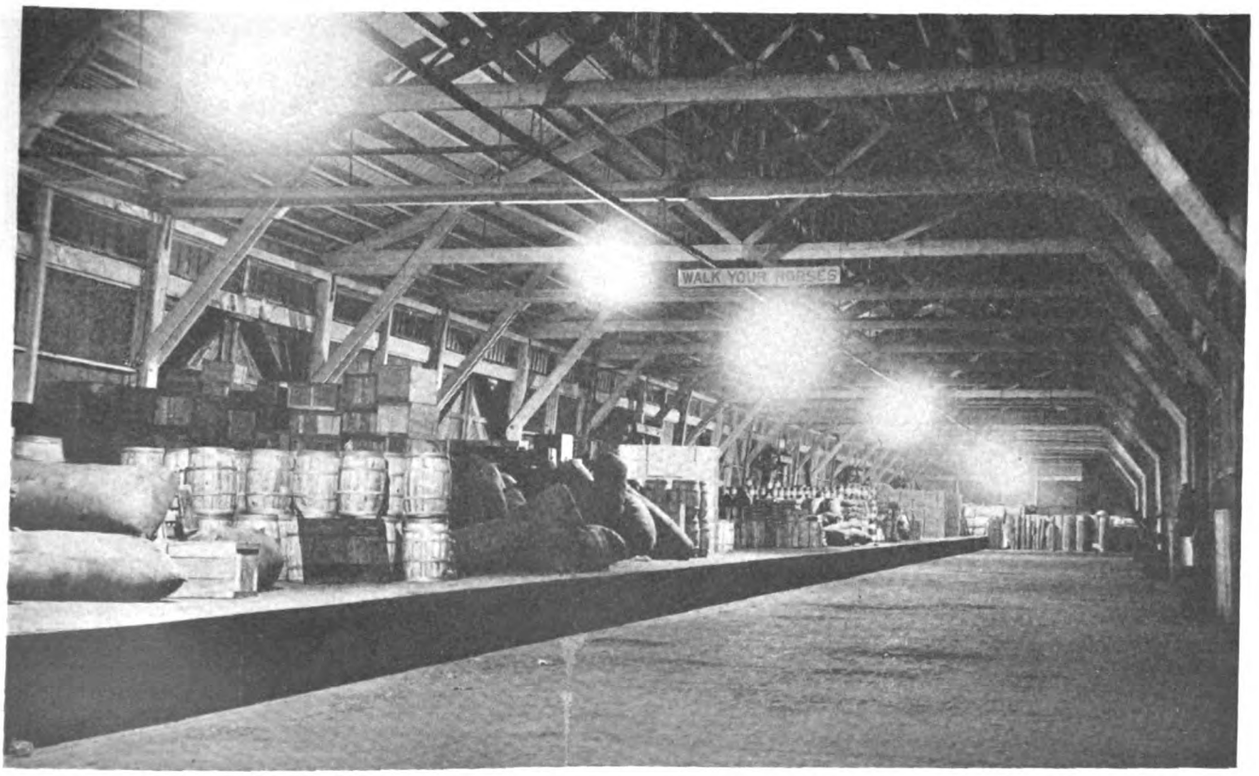

Fig. 11.—Baltimore and Ohio Freight Pier No. 11, Philadelphia, Pa.

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PORTABLE CONVEYORS AND PILING AND TIERING MACHINES

Sectionalized portable conveyors are used to great advantage for handling large quantities of packages of uniform size, small enough for two men to handle (200 to 400 pounds) at a capacity of about one ton per minute. Power consumption is very low and the machines are not expensive to install. The actuating motor may be a compound wound direct current or a squirrel cage alternating current 2-horsepower to 5-horsepower, totally enclosed or with some kind of suitable protection against moisture and dirt. Conveyors are usually furnished in 30-foot sections, but can be made shorter or longer to suit conditions. If considerably longer, several of the 30-foot sections with a motor every 30 to 50 feet may be used.

Piling and tiering machines are motor-driven conveyors capable of working at an angle up to 60 degrees. Where they can be set up and used for two or three hours steadily, each having a capacity of one ton per minute, a saving of about 75 percent in expense over hand piling and unloading may be expected.

Vertical piling and stacking machines are useful for stacking bales of cotton, hogsheads of tobacco, bales of cloth and other large packages weighing around 400 to 500 pounds and capable of standing alone on a pile three or four tiers high. They can pile to ceiling capacity and readily handle packages that do not lend themselves to slings or that are fragile. The platform can be adjusted to the height of an industrial load carrying truck or the trailing trucks of a tractor making loading or unloading easy. It is used very efficiently in connection with the elevating platform truck and the loading skids or platforms. The uprights are jointed, which permits stowing and going through the doors. An automatic overtravel device brings the platform to a stop before reaching the extreme top or bottom. The motor, either alternating current or direct current, gives a hoisting speed of 30 to 45 feet per minute. The weight of this type is not great, and, being mounted on ball bearing wheels, no hardship is involved in the frequent moves required to suit the growing or shrinking pile.

Occupying important places in the modern terminal could be mentioned the following: Escalators, telphers, industrial railways, cableways and elevators. These are all electrically operated and controlled. The elevator is a powerful freight mover, being used in buildings of more than one-story in height. These elevators in most cases are designed in sizes to conveniently carry several loaded industrial trucks or trailers.

Proper lighting of piers, freight houses and warehouses should receive special attention, especially where many men are busily engaged in handling heavy material under the pressure of the traffic of today. An average illumination of 0.15 to 0.25 watts per square foot is recommended. In warehouses the intensity of illumination, of course, should be greatest near the doors and along the main aisles. Plenty of light discourages pilfering, and light well distributed is necessary for the safety of the men and the quick and careful dispatch of freight.

Terminals and up-to-date piers are well protected by motor-driven fire pumps with reliable automatic control.

The following results may be expected from the adoption of electrical machinery:

Decreased cost of handling per ton.
Increased terminal capacity.
Increased storage capacity.
Increased handling capacity in the terminals.
Decrease in the length of time in handling.
Increased prestige of the port terminal as the outcome of these results.

Electrically operated mechanical devices of many designs for the quick, easy and efficient handling of package freight are on the market, and many others are being developed. Over seventy manufacturers are building apparatus of this kind.

Electricity is at hand and makes work easy. The central station power salesman is ready to make recommendations. The engineer has many improvements to offer from his wide experience and is ready to offer his services, with many valuable suggestions.

A closer association and co-operation of those most vitally interested, the aid of literature showing the great advantages and results gained by new developments and improvements, a more extended use of new appliances, and the use of the old, yet always new, electric power, will be the big factors in solving the freight handling problem.

> "It is a surprising fact that it costs more to load a box of canned goods on a car in Chicago than it does to carry it from Chicago to New York. It costs more to transfer a barrel of flour over the wharf to a ship in New York than to carry it by ship from New York to Liverpool. Little remains to be done in reducing the actual cost of hauling freight, as rolling stock, roadbeds, vessels and harbors have been developed or are being developed to such a high state of efficiency that any further reduction in cost at this point would be of fractional nature."
>
> —F. T. SMITH.

Wage Scale on Shipping Board Vessels

A SURVEY of the wage scale in force on Shipping Board vessels has been compiled by R. C. McKenzie, connected with the accounting department of the division of operations of the Shipping Board. In this work the basis of compilation has been the exact amount of money paid out by the operators to the crews composing the deck, engine-room and steward's departments. The exact figures for vessels of various classes are as follows:

Name	Class	Deadw't Tonnage	Number of Crew	Wages	Meals
Nansemond ...	A	15,000	162	$503.11	$171.72
Amphion	B	8,070	101	339.06	107.00
Omsk	C	.....	66	225.05	69.00
Osage	D	7,220	41	150.85	43.40
Oconee	E	4,116	35	137.50	37.10

The cost given for meals represents the average sea subsistence. On land the costs are as follows: For the *Nansemond*, $272.50 for meals and $100 for rooms; for the *Amphion*, $175 for meals and $86.50 for rooms; for the *Omsk*, $116.50 for meals and $44 for rooms; for the *Osage*, $77.50 for meals and $27.50 for rooms, and for the *Oconee*, $68.50 for meals and $27.50 for rooms.

All of the ships mentioned above are coal burners. The *Deepwater*, a class C ship corresponding to the *Omsk*, except for the fact that it is an oil burner, carried a crew of only 42 men. The wages of this crew per day amounted to $161.68. The saving in food costs over that required for the men on the *Omsk* was about $25 a day.

A national marine exposition will be held at the Grand Central Palace, New York, April 12-17, under the auspices of the National Marine League.

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The Designers and Operators of Our Ships

BY JOHN FLODIN

Much has been said about the future of our merchant marine, about the evils wrought by recent legislative enactments, and about the status of the seamen. Yet the question of obtaining intelligent and efficient seamen has received but little consideration, and that usually in the form of comment on the relatively high wages paid—based on the demands of the maritime unions rather than on the increased knowledge or efficiency of the men. After summarizing the educational situation in the field, the author of this article submits a tentative programme for the training of ships' officers and ships' draftsmen, combining practical shipyard and sea experience with specially selected college courses.

THE establishment of training schools for seamen was one of the blessings of the war. These schools, when the courses are remodeled to suit peace-time conditions, will undoubtedly prove themselves of permanent and inestimable value. But how should these courses be modified? What requirements, what educational standards, should be established for deck and engine room officers of the merchant marine? It has been said that the time has long since passed when a sailor could build himself a ship—a statement that is, in general, quite true if by ship we mean a modern steamer. But shall we tacitly accept the idea that the sailor need have no more intimate acquaintance with his ship than he can get by sailing it? Should he not have some knowledge of the process of building that ship, of the problems that entered into its design? Ninety percent of the men I associated with during eight years of seafaring knew nothing of shipyards but what they had seen when the ships upon which they sailed were drydocked.

And, conversely, should a ship designer not have more than a vague idea of how a ship behaves at sea? Would it not be far better to bring these two maritime fields together in such a manner as to assure better co-operation, deeper mutual understanding?

The fact that we must have a supercargo is a confession, first, that the ship owner and shipbuilder feel the need of information which they now lack, and, second, that the ships' crews cannot furnish the information needed. If the ships' officers cannot make the few observations desired, is it not an indication that some essential part of their training has been omitted? And is there not also something lacking in the training of the ship designer and ship operator? How many of our shipbuilders have had the opportunity of getting acquainted with a real ship in a real sea way on a real voyage? An experienced shipbuilder who held a responsible position with the United States Shipping Board recently confessed during a trial trip in rough weather that this was the first time he had realized that the stresses a vessel is subjected to are real and not mere imaginings that we deal with to satisfy Lloyd's or the American Bureau of Shipping rules.

Why Was the Supercargo Necessary?

Recently the United States Shipping Board announced the creation of a new post—the "supercargo." If the supercargo is to make observations that only the man at sea has the opportunity to make, and if these observations are to be used for the purpose of making the work of the shipbuilder and ship owner more effective, the intelligent supercargo will undoubtedly be worth his salary many times over. But the fact that we must have a supercargo is a confession, first, that the ship owner and shipbuilder feel the need of information that they now lack; and, second, that the ships' crews cannot furnish the information needed.

If the ships' officers cannot make the few observations desired—work that really should be a part of their daily tasks—is it not an indication that some essential part of their training has been omitted? And is there not also something lacking in the training of the ship designer and the ship operator? Both of these must, of course, be dependent on the reports of those who can personally observe developments; for we can scarcely expect the manager of a shipping firm to cross an ocean every time a new dock or a warehouse has been built somewhere on the other side, nor can we expect a shipbuilder to make a voyage on every ship he builds. But we can expect that both the ship owner and the shipbuilder shall have had an opportunity to gather first-hand knowledge of the things and of the conditions that will affect the success of their life work. What would you think of the president of a railroad company who engaged as manager, or even as division superintendent, a man who had never ridden in a railroad train and who had but a layman's knowledge of the various terminals of that road? What would you think of the president of an automobile manufacturing firm who hired as designer a man who had never ridden in an automobile, much less driven one? Yet, how many of our shipping men have even a fair first-hand knowledge of conditions and facilities in the ports to which they are sending their ships and their cargoes?

Shipbuilders Lack Sea Experience

And how many of our shipbuilders have had the opportunity of getting acquainted with a real ship in a real sea way on a real sea voyage? A man holding a responsible position with the United States Shipping Board told me some time ago of an experience he had had on a trial trip during which the weather had been rougher than usual. This, he confessed, was the first time he had realized that the stresses a vessel is subjected to are real, and not mere imaginings that we deal with to satisfy Llyod's or the American Bureau of Shipping rules. And he was a man advanced well into middle age, with many long years of shipbuilding experience behind him. Another instance: An Englishman, also a man of authority and of long and varied shipbuilding experience, admitted to me recently that the only chance he had ever had of

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observing a ship working in heavy weather was when he immigrated to this country—and then he had been too seasick to know what was going on.

In spite of this glaring lack of sea experience on the part of a very large majority of our ship designers, there is a great deal of unwillingness among them to accept the advice or the suggestions of the seaman, as relating to questions of shipbuilding. This unwillingness is not entirely unwarranted, for not only is there a lack of confidence in the judgment of the seaman, but on the part of the seaman there is a real and decided lack of understanding of shipbuilding problems. It is true that the relations between the ship designer and the seaman, especially when the latter is serving as the owner's representative, are usually very cordial—on the surface at least—but there is nearly always an undercurrent of distrust, an unexpressed accusation of ignorance and incompetence. The seaman knows that the designer does not fully understand ship problems, because of lack of sea experience, and feels that he cannot make himself understood, while the draftsman feels that the seaman does not understand the engineering principles that must form the basis for every design. The designer is often a college graduate; the seaman almost never is. And why should he not be?

Inadequate Educational Facilities for Seamen

But is this lack of increased knowledge entirely the fault of the seamen? What has been done towards raising their standards? Very little indeed, and that little—known as the LaFollette act—has caused a never-ending storm of complaint and abuse, perhaps chiefly because the movement was staged by the seamen's unions. The high cost of living has been used as an argument for the obtaining of wage increases. It should be remembered, however, that the increased costs have affected seamen only in their buying of clothing and luxuries, since their food is included as part of their wages, and since they usually are not married. Yet, if we compare the work and life of the merchant seaman with the conditions obtaining in almost any field ashore, we cannot help feeling that the seamen are more sinned against than sinning. Up to the time of our entry into the war, what kind of educational facilities had we offered them? Of course, the public schools were open to them. But how often have we heard of an engineer, or a mate, or a steward asking the boy who is seeking his first job on shipboard whether he has graduated from any school, or even whether he can read and write? Seamen were not encouraged to attend school: indeed, the idea was generally prevalent that the sea was a good place for the boy who was good for nothing else, an idea that was probably a relic of the days when the galleys were manned by slaves and by convicts.

To satisfy the need for education specifically required by seamen who had enough ambition to want to get a license, a number of so-called navigation and engineering schools were established. They were private institutions conducted for profit, and a large part of the profit was derived by compelling the students to buy the very indifferent text-books written by the very indifferently qualified masters of the schools. It is scarcely necessary to add that the curriculum did not contain any information that would not be needed to enable the student to answer the questions that the inspectors would be likely to ask during the license examination. It is true that some universities were offering, and are still offering, courses in nautical astronomy. These courses, however, were not planned to fill the needs of the aspirant for a mate's license, nor were they of such a nature that he could be admitted to the classes without long, laborious and expensive preparatory studies. It is true that candidates for engineer's licenses could well have benefited by the courses in steam engineering offered at numerous colleges and universities, assuming that their preparatory schooling satisfied the matriculation requirements; but they were not encouraged to take advantage of these opportunities. In addition to these facilities, there were the training ships which gave their charges instruction in both seamanship and navigation, offering a somewhat more thorough training. These schools seemed intended primarily to reduce the hardships of the first years at sea, and to thus make the sea career somewhat more attractive, rather than to materially raise the standards. The facilities of this kind were, and still are, very limited.

> The courses here outlined could be offered with little additional cost by any university or college having an engineering department. If in selecting quartermasters and junior officers preference were given to men who had covered all or most of the educational programme decided upon, we would soon have available the necessary material for building up a corps of officers that would have not only a different educational standard, but also a different conception of their work and a new *esprit de corps*.

Many American universities and colleges offer two- and four-year courses in pharmacy to furnish the necessary preparation for the successful operation of a drug store. Most of our universities and colleges offer four- and five-year courses in commerce, and if the most successful graduates become bank presidents we feel that the educational expense was well warranted. The druggist can, through ignorance or carelessness, wreck but few lives and cause but little material damage before he is put out of business. The banker may, through lack of adequate training, cause considerable suffering, but he has not the power to *utterly destroy* lives and property. On the other hand, the seaman who climbs above the average of the rank and file, the man to whom we extend no educational helping hand, has it in his power to obliterate the lives of scores, possibly of thousands, of human beings and millions in property.

Efficiency a Product of Education

We have been told that it is difficult, if not impossible, for the American merchant ship to compete with foreign shipping because of the higher pay of the American sailor, both in cash wages and in the greater expense for better and more abundant food. It has been pointed out that higher wages and better food do not necessarily mean greater efficiency, since American vessels are compelled to carry larger crews than ships flying foreign flags. Would this not assume a different aspect if our seamen were educated and trained, not with any intention of reducing the size of the crews, but with a view to obtaining the services of men who would be able to suggest improvements and to offer intelligent criticism? I am not asking that we find or create crews of inventors for our ships. Education and training do not produce inventors—a child may conceive the idea of utilizing the energy contained in steam; but education and properly guided training do produce men who are capable of improving existing inventions—men who can refine the steam engine until

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its fuel consumption is cut down to but a fraction of what had been thought possible.

EDUCATIONAL PROGRAMME FOR SHIPS' OFFICERS

The question of just what would be the most desirable educational preparation and training for these men requires careful consideration on the part of all those who are connected with shipbuilding and shipping. As a very preliminary outline of what should be regarded as a transitory step, the following might serve:

DECK OFFICERS

First two years, at sea, six months of which should be spent in the engine room, on board a merchant or training ship.

Third year, special college course, comprising the following subjects:

- Mathematics—rapid survey of elementary mathematics, including logarithms; solid geometry; a brief course in trigonometry, including the elements of spherical trigonometry
- Mechanical Drawing
- Mechanics and Strength of Materials—as complete an exposition as can be given without calculus, with special reference to the strength of a ship as a whole
- Shipbuilding—types of ships; general survey of powering and resistance problems
- Steam Engineering—a course of descriptive nature, covering steam engines, turbines, boilers and auxiliaries.

Fourth year, in the shipyard, preferably under special apprenticeship arrangement, whereby the time can be divided among several departments, such as the mold loft, the fitting department and the hull drawing office.

Fifth year, special college course, comprising the following subjects:

- Mathematics—a brief course in differential and integral calculus
- Nautical Astronomy
- Navigation and Rules of the Road
- Commerce and Commercial Geography
- Ship Caluculations, with special emphasis on stability
- Medicine—first aid, diagnosis and treatment of common ailments, hygiene.

ENGINE ROOM OFFICERS

First two years, at sea, six months of which should be spent on deck, on board a merchant or training ship.

Third year, special college course comprising the same studies as for deck officers.

Fourth year, in the shipyard, preferably under special apprenticeship arrangement whereby the time can be divided among several departments, such as the pattern shop, the machine shop and the machinery drawing office.

Fifth year, special college course comprising the following subjects:

- Mathematics—a brief course in differential and integral calculus
- Mechanisms
- Steam Engineering—a descriptive course covering steam engines, steam turbines, boilers and auxiliaries
- Steam Engine Design, with special reference to valve motions
- Steam Boiler Design
- Engine and Boiler Testing, with special reference to indicator work, including valve setting from indicator diagrams
- Internal Combustion Engines—a descriptive course
- Dynamos and Motors—a descriptive course, but including the principles of electricity and magnetism
- Ship Calculations—including resistance and powering, with special reference to propeller problems
- Medicine—first aid, hygiene.

It will be noted that the college work is cut down to the barest essentials, representing one-half the time outlay required for the engineering courses offered as preparation for work of considerably less importance and responsibility. At present we send a man to college for four or five years as part of the preparation for his taking charge of a power plant where a breakdown is not likely to have any more serious result than an unpleasant interruption of service. On the other hand, the man we place in charge of a *ship's* power plant is not encouraged to spend a single day in college, and we are more likely to inquire into the number of years of sea experience he has had than into his high school career. Yet such a programme as is here outlined could readily be put into execution without very great expense. The nature of the courses outlined is such that they could be offered by any university or college having an engineering department at but little additional cost, and their installation at the present training schools should not prove a very difficult task.

PROPOSED COURSES FOR SHIP DRAFTSMEN

The training courses proposed above, up to and including the first year of college work, are so similar that a change could be made from one branch to the other without great loss of time if a student so desired. It should also be clear that all or any part of this training would be a very useful asset to ship draftsmen, although the following suggested schedule would serve as a better preparation for that field of work:

HULL AND ENGINE DRAFTSMEN

First two years, at sea, about one-half of which should be spent in the engine and boiler rooms, dividing the time preferably among several merchant ships.

Third year, special college course comprising the following subjects:

- Mathematics—algebra, trigonometry, solid geometry, with special reference to the geometry of shipbuilding
- Drawing, including elementary problems in descriptive geometry
- Mechanics and Strength of Materials, with special reference to ship work
- Mechanisms
- Shipbuilding—types of ships, tonnage, laying-off
- Ship Calculations—elementary course
- Steam Engineering—elementary course, both descriptive and analytical

Fourth year, special college course comprising the following subjects:

HULL DRAFTSMEN

- Mathematics—a brief course in differential and integral calculus
- Ship Design—general considerations, structural drawing, hull fittings, rigging and rigging details
- Ship Calculations—continuing and supplementing the first-year course
- Commerce.

STEAM ENGINEERING DRAFTSMEN

- Mathematics—a brief course in differential and integral calculus
- Steam Engine Design
- Steam Boiler Design

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Engine and Boiler Room Auxiliaries
Internal Combustion Engines—descriptive course
Steam Turbines—descriptive course
Engine and Boiler Room Piping
Ship Calculations—resistance and powering, with special reference to propeller design
Commerce.

These very brief courses of preparation should be rounded off with a one-year apprenticeship arrangement in the shipyard, by which the student is permitted to spend a short time in each of several departments.

Naval Architects and Marine Engineers Need Sea Experience

It is not intended that the courses here outlined for ship draftsmen should supplant the four- and five-year courses now being offered in naval architecture and marine engineering. On the other hand, they are intended rather to replace the present apprenticeship arrangements, which in practically all our shipyards leave the youth to pick up what he can during working hours and to get supplementary—and often ill-suited—instruction in evening schools at his own option. Not only have I no desire to weaken the present longer courses, but I should like to have them strengthened by adding the requirement that the student spend at least his vacations at sea, or, preferably, his vacations in the shops of a shipyard and one or two years at sea after graduation, or between his fourth and fifth collegiate years in case he is taking a five-year course.

The Probable Effect of the Proposed Programme

It may perhaps be objected that this educational scheme would tend to give rise to an aristocracy on shipboard and in shipyards. I think we have at the present time about all the aristocracy on shipboard that one could wish, but this aristocracy is not based, to as large an extent as it should be, on mental superiority. Anyone familiar with sea life knows how sharply the lines are drawn between the men "before the mast" and the men holding officers' berths, although little mental difference exists. In shipyards the spirit is more democratic, and I think it may truthfully be said that the college-trained men who have entered this field have not been guilty of making it less so.

If, in selecting quartermasters and junior officers, preference were given to men who had covered all or most of the educational programme decided upon, we should soon have available the necessary material for building up a corps of officers that would have not only a different educational standard, but also a different conception of their work and a new *esprit de corps*. When this has become apparent, men will not drift into sea life with the intention of sailing a few years, haphazard, and then perhaps taking a six-months' course in navigation or steam engineering in order to get a license. Under that system a man picks up what he can, usually without guidance. His experiences are often of the richest, but his education is usually too meager to enable him to derive even a reasonable amount of benefit from them.

New System Would Attract Better Men

Perhaps, however, the greatest benefit accruing from the raising of the standards—or, better, from the establishing of educational standards—would be to stimulate American young men to take up sea life. Some time ago a young man, a high school graduate, told me that the reason why he had quit the sea, after having sailed for two years, was that he found that he was forgetting more than he was learning. The prospect of becoming an officer had not appealed to him, he said, because even as an officer he would have had to recognize as his superiors men who, he felt, were more ignorant than he. He probably attached too small importance to the value of practical experience.

On the other hand, a large majority of the men going to sea would probably object to the idea of attending college or even high school classes. The average boy, who scoffs at higher education, harbors a secret ambition to show the world that he can successfully compete with men of greater educational attainment. When he begins to realize the greatness of the handicap, he very often—usually secretly—takes night school or correspondence courses. He is not easily discouraged and does not readily give up the race. He wants to be, and often, simply because of the stimulus of keen competition, turns out to be "as good as the next man."

But such competition does not now exist either on shipboard or in the drawing offices of our shipyards. After a man "serves his time," if he has chosen the sea, he takes an examination that represents a minimum of knowledge; subsequently, the question of whether or not he is really qualified to fill an officer's berth is left to the arbitrary decision of the captain, the chief engineer, or the owner of the ship, who, of course, must accept some one of the candidates, even though he may feel that the education or training of the man chosen does not warrant placing great responsibility in his hands. If the man happens to be a draftsman, his rating is determined (according to the Macy board award) on the basis of the number of years of experience he has had. This training may or may not have made him a real asset to the industry and to the country.

American Ship Men as Leaders, Not Followers

Doubtless any improvement in shipbuilding or ship operation which might be brought about by men thus trained at national expense would soon be copied by other countries. Therein lies the secret of success. If we can lead and innovate where we have been copying and imitating, if we can keep our beacon shining a little in front o' the next, and leave him sweating and groping a year and a half—or a decade and a half—behind, we need not fear for the future of the American merchant marine.

Trials of the First Steamer Completed by the Australian Government

THE S. S. *Dromana*, the first ship to be completed under the Australian Commonwealth shipbuilding scheme, ran her trials on August 9, 1919. The trials were in every way satisfactory, the vessel attaining a speed of 11.8 knots.

The party on board included the Hon. A. Poynton, minister in charge of shipbuilding; members of the Federal Government, and a representative of the Victorian State Government; representatives of Melbourne commercial circles; Mr. Rex. Thompson, representing the engineers; Mr. H. W. Curchin, chief executive officer of Commonwealth ship construction, and Mr. Watson, engineer of the ship construction department.

The vessel has a length of 341 feet, a beam of 48 feet, and a molded depth of 26.1 feet. She is built on the Isherwood system of longitudinal framing, of single deck type, with poop, bridge and forecastle, and classed 100 A-1 at Lloyds. She has exceptionally large hatches and ample cargo handling equipment, consisting of eleven winches and eleven derricks, including one 20-ton derrick The captain and officers are berthed amidships, the

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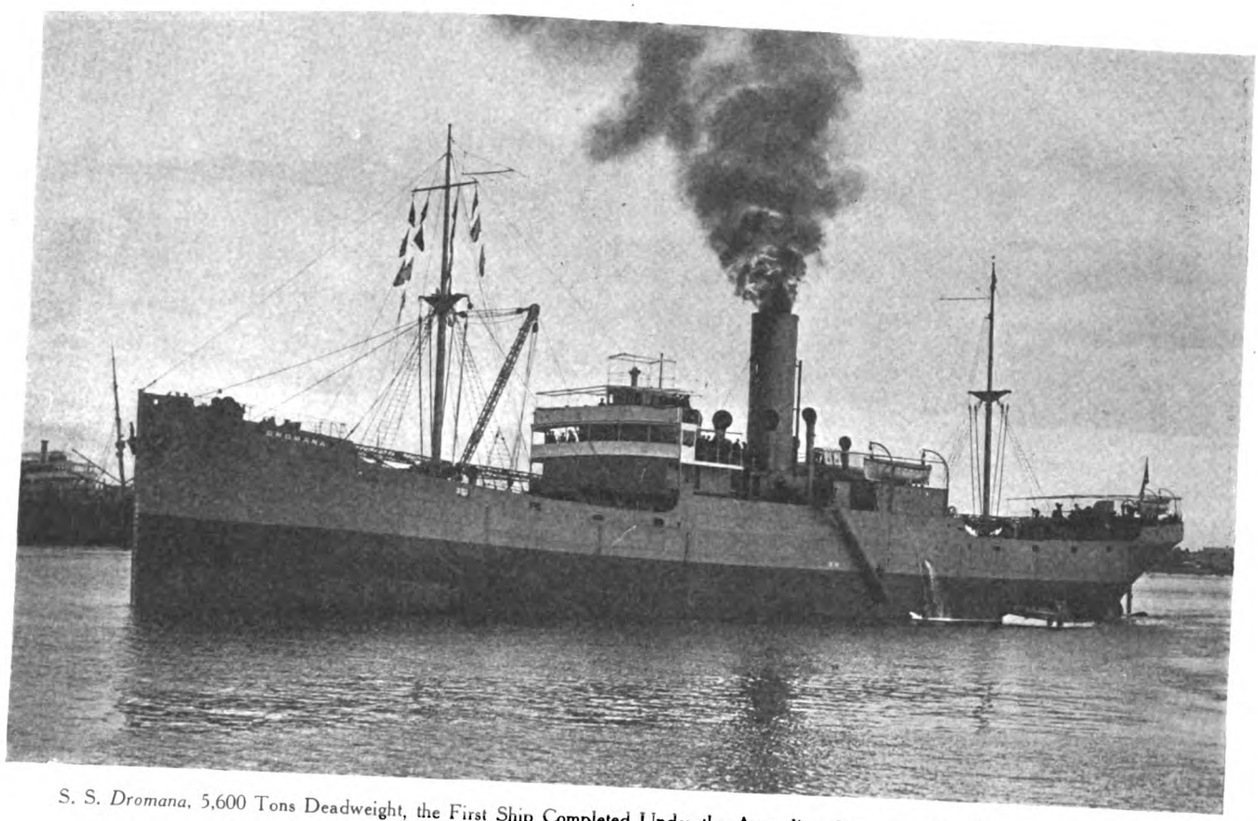
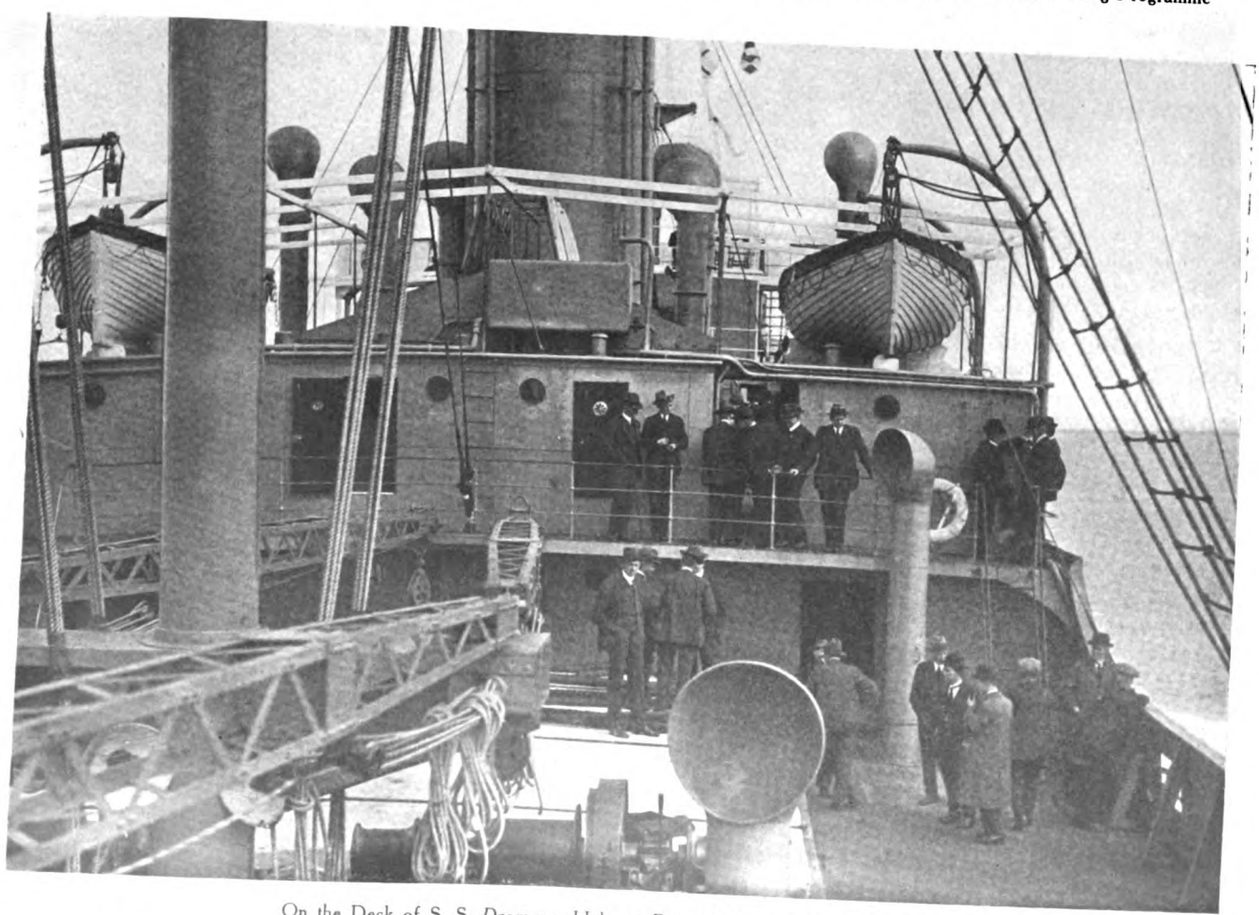


S. S. *Dromana*, 5,600 Tons Deadweight, the First Ship Completed Under the Australian Commonwealth Shipbuilding Programme



On the Deck of S. S. *Dromana*, Hobsons Bay, Melbourne, August 9, 1919

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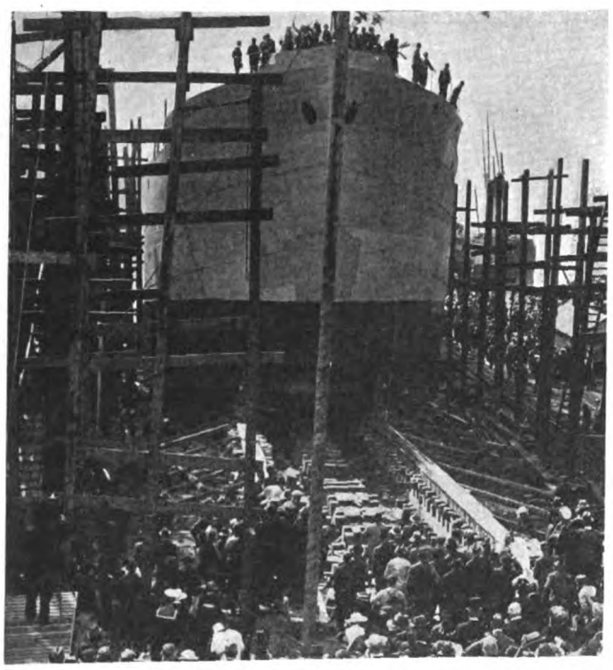


Launching of S. S. *Dromana* at Williamstown on April 11, 1919

engineers being on the bridge alongside the engine casings. The crew is berthed in the poop. All accommodations are ample in size, with separate mess rooms for firemen and sailors, as well as baths and washrooms.

The vessel will carry 5,600 tons deadweight on a 21.9-foot draft and was built at the Commonwealth Government yard at Williamstown.

The machinery consists of triple expansion engines with cylinders 25, 41 and 68 inches diameter and 45-inch stroke, and three Babcock & Wilcox watertube boilers designed for a working steam pressure of 180 pounds per square inch. The machinery was constructed by Messrs. Thompson & Company, Castlemaine, Victoria. With the exception of a portion of the steel plates, special parts for the boilers and a few items of equipment, the material and auxiliaries were manufactured in Australia.

Australian Federal Fleet Construction

THE Australian Commonwealth Government, in pursuance of a policy of shipyard expansion, is carrying out an extensive programme of new construction. At the Government Dockyard, Walsh Island, Newcastle, a contract for three 12,000-ton steamers has recently been placed. These ships are to be used in the meat-carrying trade, and for this purpose the holds will be insulated and up-to-date refrigerating equipment installed. Although the Newcastle yard is the largest in Australia, additional machine equipment is necessary to accommodate these vessels because of the previous contracts being carried on simultaneously.

Construction of six vessels of the *Delungra* type, built on the Isherwood system, is progressing rapidly. Two of the vessels launched in the spring are approaching the point at which they can be taken on their trials, while a third, the *Dundula*, was launched in July. The preparation of the plates, frames, etc., for the remaining three was carried out on a production basis at the same time, so that the remaining work is practically an assembling proposition.

These ships are of the well-deck type, having the following dimensions:

Length	331 feet
Beam	48 feet
Molded depth to upper deck	26 feet 1 inch
Deadweight tonnage	5,500
Engines	Triple expansion
Indicated horsepower	2,200
Boilers	Babcock & Wilcox
Speed	10½ knots

The vessels are being built at an average cost of $775,000 (£159,000).

Additional Building Programmes

In addition to the first contracts, fourteen more vessels are contemplated immediately. Two will be built at the Commonwealth Dockyard, Williamstown; three at the Dockyard, Walsh Island; one at Cockatoo Island; four at Walkers, Ltd., Mayborough, Queensland, and four at Pool & Steel's, Adelaide. All these ships are to be of the shelter deck type of the following dimensions:

Length	331 feet
Beam	48 feet
Molded depth to upper deck	33 feet 7 inches
Deadweight tonnage	6,000
Engines	Triple expansion
Indicated horsepower	2,200
Boilers	Babcock & Wilcox

Auxiliary Schooners

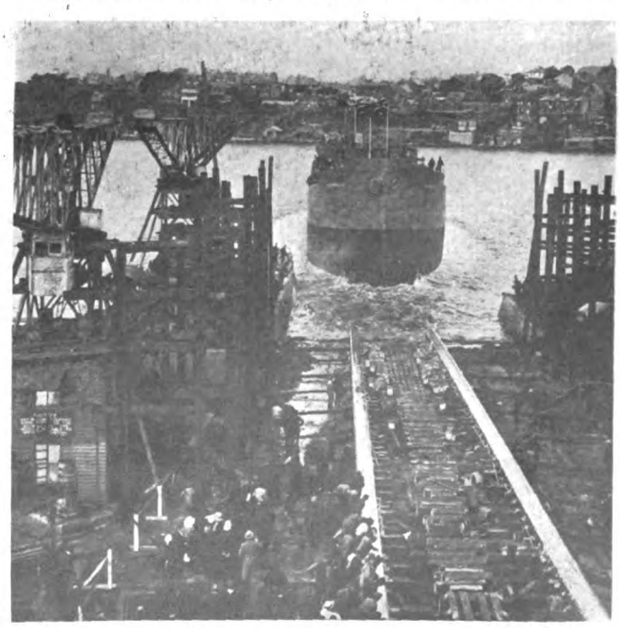
Two wooden five-masted auxiliary schooners are under construction. The dimensions of these vessels are:

Length	250 feet
Beam	45 feet
Molded depth	24 feet 5 inches
Deadweight tonnage	2,600
Engines, two sets	Bolinder semi-Diesel
Brake horsepower, each	240
Revolutions per minute	240
Speed	7 knots

The contract price for the vessels is $130 (27/1/8) per deadweight ton.

Proposed Contracts

Negotiations have been completed for the construction



Launch of the S. S. *Dundula*, Third of the Commonwealth Standard Ships, from the Commonwealth Naval Dockyard, Sydney, N. S. Wales, July 9, 1919

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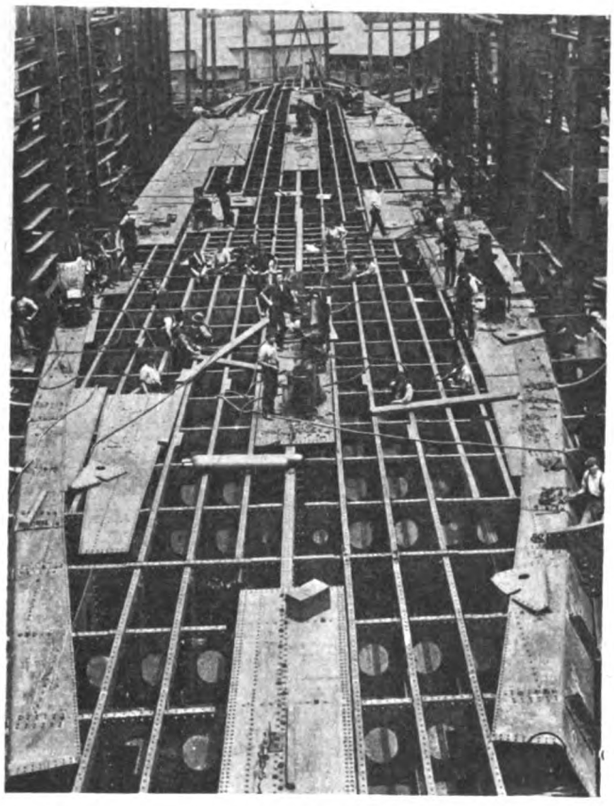

Steamship *Dundula* in Course of Construction, Showing Riveters at Work on Tank Top

of four vessels larger than any previously planned, with the possibility of two additional later. The details of the construction are:

Length	520 feet
Beam	62 feet 3 inches
Molded depth	45 feet
Deadweight tonnage	12,800
Speed	13 knots

The holds will be so arranged that 260,000 cubic feet of insulated space will be available for the stowing of frozen meat or chilled produce. The vessels will each cost about $2,115,000 (£412,500).

STEAMSHIP DUNDULA

At the Cockatoo Island yard the third vessel, the *Dundula*, contracted for on the original programme, was launched July 9, 1919. This vessel is of the single-deck type, with a long bridge deck amidships. The crew is accommodated in the poop, the officers and engineers on the bridge deck, and the captain and wireless operator on the navigating bridge. All the ship's stores are carried in the forecastle. There were altogether 1,460 tons of steel used in building the vessel, of which about 876 tons were fabricated in Australian steel mills. The pumping and drainage arrangements are very complete for a vessel of this size.

The main framing of the vessel consists of bulb angles averaging from 7 inches to 9 inches, running nearly the full length of the vessel at a distance of 28 inches apart. They are supported by transverse frames, which consist of web plates varying in depth from 14 inches to 42 inches and supported by face angles connected to the plating.

The transverse frames, which are spaced from 11 to 12 feet apart, form a continuous web with the upper deck beams. The longitudinal and transverse framing, together with the shell and deck plating, form the main factor of strength in this type of vessel. Five watertight bulkheads add to the strength and stiffness of the structure.

The collision bulkhead is situated about 20 feet from the forepeak. At the after side of this bulkhead the cargo hold begins and extends about 140 feet to the coal bunkers. Aft of the coal bunkers are the boiler and engine rooms, and another cargo hold which extends to within 35 feet of the stern frame. The vessel is designed to carry a cargo of 5,500 tons deadweight. She will displace about 9,000 tons when fully loaded.

Power is provided by steam generated in three Babcock & Wilcox boilers of the watertube type having a heating surface of 8,289 square feet. Only those parts have been imported which could not be made in Australia.

The engines were manufactured by Messrs. Thompson & Company, of Castlemaine, Victoria. They are of the triple expansion type, 25 inches by 41 inches by 68 inches cylinder diameter, and 45-inch stroke. They will develop 2,200 indicated horsepower. The same type engines are being installed in the class-C ships in Great Britain. They weigh about 100 tons; their dimensions are: length, 21 feet 3 inches; width, 16 feet; height from the sole plate to the top 23 feet.

The auxiliaries include the condenser with a cooling surface of 2,600 square feet; several large Weir-type feed pumps, ballast pumps and a 25-ton evaporator. The Weir-type pump has proved itself quite the best for the purpose and is generally installed in Australian ships. Other accessories, all of which have been turned out in the Dockyard workshops, comprise pumps, feed heaters, filters, condensers, winches, electric light engines, windlasses, steering engines, auxiliary screw gear, ventilating fans and fan engines, etc.

Steamship Coaling Equipment*

A SELF-CONTAINED coal digging unit intended for use in coaling ships through side ports has been arranged to hang on the side of the steamship to be coaled, Fig. 1. The machine may also stand on the deck of a steamer near the rail, and by using cars, wheelbarrows or portable conveyors the coal can be loaded into the deck hatches.

Self-filling grab buckets are universally used throughout the world for digging coal from barges and discharging at coaling stations on shore. It is quite certain that this is the only practical and economical way to handle soft coal. A number of these shore digging plants have been designed and installed for the Navy Department. The steamship coaler is really a miniature of the shore plant.

CONSTRUCTION OF COALER

The machine consists of a light structural steel *A* frame to which is attached the hoisting motors and machinery. The frame also supports the receiving hopper with a telescopic flexible chute at the bottom. The lifting boom is pivoted on the *A* frame and the bucket is suspended by ropes from this lifting boom.

A seat is provided for the single operator with convenient control levers. An extension hook is provided at the top of the *A* frame so that the machine may be hung from the bulwark or side plating of a steamship. Heavy chains with hooks are also provided to take the weight of the machine, as shown by the illustration, in which case a top lashing or turnbuckle with a hook is used to take the outboard pull of the machine at the top.

The grab bucket is a standard clam shell, self-filling bucket of the same type used in shore plants and has a capacity of one-third of a ton of bituminous coal. The

* Courtesy of Bergen Point Iron Works, Bayonne, N. J.

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topping up of the boom is automatically controlled by a conical-shaped differential drum, shown in Fig. 2. The operator has only to hoist and lower the bucket, which automatically swings in over the hopper to its dumping position without attention on the operator's part.

Operation of the Bucket

The maximum reach of hook is 14 feet from the center-line of the machine and the minimum reach is 9 feet 9 inches. By utilizing the swing or pendulum motion of the bucket when lowering, this is ample to take care of barges up to 32 feet beam. The hoisting and closing motors are of 15 horsepower each and can use either direct current or alternating current. An electrical connecting plug is provided on the machine so that a wire can be run from the steamship to furinsh the machine with current.

The bucket has a capacity of 50 tons an hour when there is plenty of coal within reach. This capacity, however, is reduced somewhat when the bucket is cleaning up coal from the bottom of a barge.

Method of Installing Coalers

The total weight of the machine is about 4½ tons and it can be quickly and easily hung in place on the side of the steamship by means of a derrick lighter. About five minutes is required for the derrick lighter to hoist and hang the machine in place, and even less time to take it down.

It should be noted particularly that the whole machine is self-contained, and after hanging in place all that is necessary is to put in the electric plug before beginning operations.

A number of machines should be stored on a derrick lighter which is to be used to hang the machines in place. For hanging the machines on the inshore side of the steamship, adjacent to the dock, the machines should be stored on the dock and swung in place by a derrick from the dock. The best method is to design the derrick lighter with a very low clearance line, so that the lighter might go underneath the mooring lines and gangplanks.

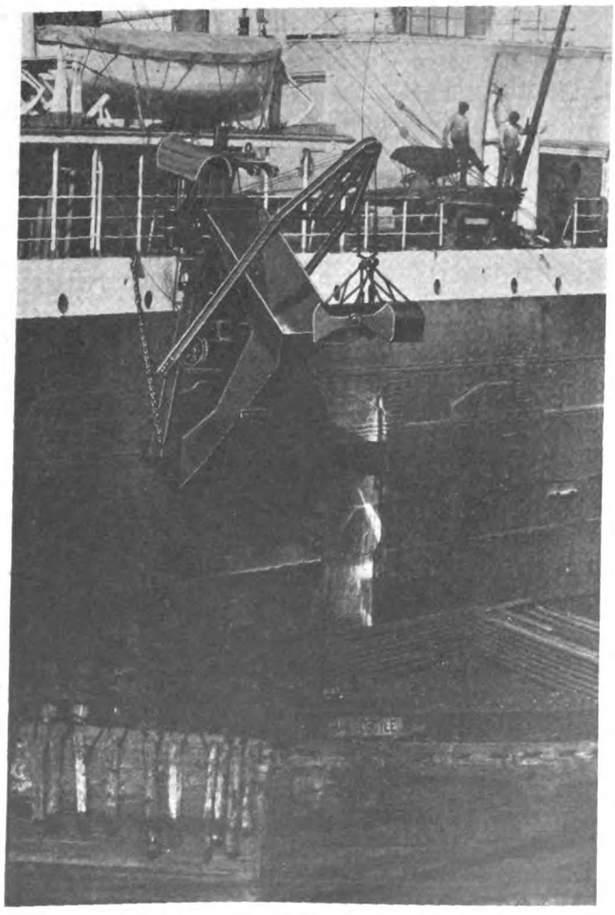

Fig. 1.—Self-Contained Ship Coaling Unit

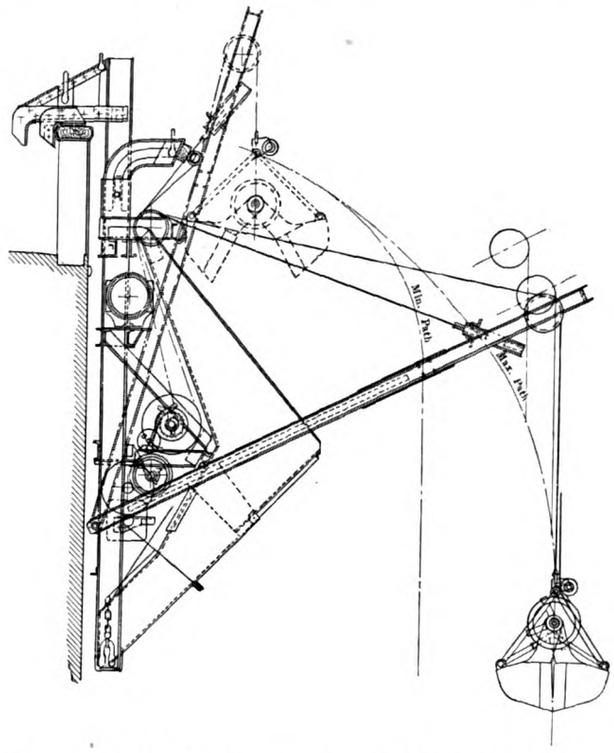

Fig. 2.—Details of Coaling Equipment, Showing Method of Operation

It is claimed that a single operator on a coaler will handle more material than a stevedore's gang with hand-filled tubs. Such a stevedore's gang usually consists of twelve to fourteen men. When cleaning up the bottom of the coal barge with the bucket a couple of trimmers will be required in the barge.

Ship Construction and Marine Transportation Added to Courses of Study at Lehigh University

LEHIGH UNIVERSITY offers a four-year course in ship construction and marine transportation leading to the degree of naval engineer (N.E.). Its purpose is to prepare men to engage in the design, construction and operation of ships, and to enter the field of marine transportation. The course is a combination of engineering and economics preceded by the fundamental subjects common to engineering courses; chemistry, modern languages, physics and mathematics. Combining, as it does, engineering training with studies in economics and business administration, such a course has been planned to develop men who, in addition to a knowledge of conditions governing ocean and inland water transportation, will have a command of the technical, economic and financial aspects of ship design, construction and operation. The course is as follows:

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THE COURSE IN SHIP CONSTRUCTION AND MARINE TRANSPORTATION

FRESHMAN YEAR

First Term	*Second Term*
Advanced Algebra (3)	Plane Analytic Geom. (3)
Elementary Chemistry (2)	Spherical Trigonometry (1)
Chemical Lab. (2)	Qualitative Analysis (3)
Elementary Mechanics (3)	Stoichiometry (1)
French (3)	Elem. Mech. & Heat (3)
or Spanish (3)	Physical Measurements (1)
or German (3)	French (3)
Engineering Drawing (3)	or Spanish (3)
Construction (2)	or German (3)
Gymnasium (1)	Engineering Drawing (2)
	Construction (2)
	Gymnasium (1)

Summer Term: Land and Topographic Surveying

SOPHOMORE YEAR

First Term	*Second Term*
Differential Calculus (4)	Solid Analytic Geom. &
Electricity & Magnetism (3)	Integral Calculus (4)
Mechanics & Heat Lab. (1)	Light & Sound (3)
English (3)	Light, Elec. & Mag. Lab. (1)
French (3)	English (3)
or Spanish (3)	French (3)
or German (3)	or Spanish (3)
Economics (2)	or German (3)
Ship Construction (3)	Naval Architecture (2)
Physical Education (1)	Accounting (2)
	Ship Construction (2)
	Physical Education (1)

Summer Term: Work in Shipyard on Hull Construction

JUNIOR YEAR

First Term	*Second Term*
Strength of Materials (4)	European History (3)
Strength of Materials Lab. (1)	Hydraulics (3)
Naval Architecture (3)	Hydraulic Lab. (1)
Dynamos & Motors (2)	Alternating Currents (2)
Dynamo Lab. (1)	Dynamo Lab. (1)
Heat Engineering (3)	Marine Engineering (3)
Business Law (2)	Steam Engineering Lab. (1)
Astronomy & Navigation (2)	Finance (2)
Physical Education (1)	Machine Design (3)
	Physical Education (1)

Summer Term: At Sea or in Shipyard Machine Shop

SENIOR YEAR

First Term	*Second Term*
Naval Architecture (2)	Metallurgy (3)
Ship Design (3)	Ship Design (4)
Marine Engines & Turbines (4)	Reinforced Concrete (3)
Steam Engineering Lab. (1)	Contracts & Specifications (2)
Structural Steel Design (4)	Foreign Trade (4)
Foreign Exchange & Marine	Shipyard Plants &
Insurance (3)	Terminal Facilities (3)
Industrial Management (2)	Physical Education (1)
Physical Education (1)	

The Dangers of the Oil Room

BY S. D. RICKARD*

IN considering the dangers attendant upon the storage and handling of oils, we are apt to think only of gasoline (petrol) and naphtha. This is a great mistake, as every oil carries with it a menace to life and property, and its handling should be safeguarded in every possible manner. Until this fact is universally recognized and all oils are handled in fire-proof, evaporation-proof steel storage tanks, we must expect to pay an enormous fire loss due to the careless handling of these products. It is true that the danger of handling gasoline (petrol) is greater than in handling other oils. This danger is so well known, however, that familiarity with it has in many cases induced carelessness, so that it is well that we consider the treacherous nature of this product, that we may always be on our guard.

Gasoline (petrol), unlike the other heavier petroleum products, throws off an explosive vapor constantly, even at extremely low temperatures. Five gallons of gasoline (petrol) will generate 8,000 cubic feet of gas, which, when ignited, expands to 4,000 times this space. The explosive force of one gallon of gasoline (petrol) properly mixed with air and compressed is equal to 83⅓ pounds of dynamite, or fourteen times greater than dynamite. This means that if you have 100 gallons of gasoline (petrol) on hand, you are storing the equivalent in explosive force to 8,366 pounds of dynamite. Gasoline (petrol) is, in fact, more dangerous to handle than dynamite, and there is more liability of an explosion. Dynamite will only explode from two or three causes, which may be easily guarded against and which must occur in its immediate vicinity.

Dangerous Gasoline (Petrol) Fumes

The vapor from gasoline (petrol) is heavier than air. It settles to the floor and runs along the floor much as a stream of water would, only that it is an invisible stream. This vapor will settle and remain in a depression in the floor or under the floor for days and even weeks, unless disturbed by a circulation of air, until a spark causes the accumulated vapor to explode. This spark does not necessarily have to come from a lighted fire, but may occur through a person striking a nail in their shoe on a nail in the floor or other similar unavoidable causes. The records show that under certain atmospheric conditions, spontaneous combustion will occur in this accumulated vapor. A case is on record in which the gasoline (petrol) fumes were carried outside of a building to a lighted lamp thirty feet away from the building, taking fire and flashing back to the building, which was entirely consumed. If you are handling gasoline (petrol) in any way but the right way, you are in just this position and you can never foresee when the blow will fall.

It is past understanding, in view of these facts, that many concerns, with their entire capital invested in the business, will give so little thought to safeguarding their interests. With the factory, shop, mill or mine heated, they will at night lock up this explosive in a warehouse or building adjacent to or connected with the main plant. After locking up fire and this explosive vapor together, they will, in effect, wager their entire investment against the merely nominal expense of fire-proof storage that this vapor and this fire will not get together.

Kerosene (paraffin) is not as dangerous as gasoline (petrol), yet at a temperature of 70 degrees F. or over it throws off an explosive vapor. At a higher temperature, say 80 degrees F., in order properly to ventilate a room in which there is an open tank of kerosene (paraffin), there should be kept up a circulation of air equal to 200 cubic feet per minute for each gallon of the exposed oil. These figures vary, of course, with the volatility of the oil and the temperature of the air and oil. Such a circulation of air is not practical in the usual manufacturing establishment. Hence the necessity is apparent for evaporation-proof, scientifically correct storage for kerosene (paraffin), as well as for gasoline (petrol).

Dangers from Paint Oils

All petroleum products, including lubricating oils, produce this explosive vapor. The danger from lubricating oils, however, is chiefly from spontaneous combustion where waste, sawdust or shavings are used to absorb the oils spilled on the floors. Many fires in factories and oil rooms have been traced directly to this cause, as it is a very common practice to neglect the accumulated refuse, which, in time, bursts into flames.

The gravest danger that confronts the consumer of oils aside from the gasoline (petrol) danger is, however, from

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the paint oils, such as linseed oil and turpentine. A piece of cotton waste saturated lightly with equal parts of linseed oil and turpentine will, if left in a closed room, such as an oil house or storeroom, for the night, burn from spontaneous combustion in three hours' time. Instances are not even lacking of fires being started in this manner when the waste or oil-soaked cloth was left in the open air. Two years ago a fire occurred in Minneapolis from a cloth which had been used in oiling a floor and was left on the porch. North Dakota has, in the past year, suffered a loss running up into hundreds of thousands of dollars from fires started by spontaneous combustion in oil houses. This property loss is appalling, but who can estimate the value of lives sacrificed annually to the mistaken policy of "economy" in equipping an oil room?

We are living in an age of increasing danger to life and property from many causes unknown to our fathers. Developments of modern inventions in all lines, such as electricity, automobiles, etc., each brings its corresponding increase in danger to life and property. These advances in the development of our civilization bring a responsibility that we cannot ignore. The merchants and the factories today are compelled to meet the conditions. For instance, they are compelled to store large quantities of various dangerous oils. Happily, we are also in an age when master minds have set themselves to the problem of minimizing all such dangers. The storage and handling of oils has been reduced to an exact science, so that there are now available means of handling gasoline as safely as spring water.

Safety Equipment for Handling Oils

Special equipment has also been designed for handling each and every oil in a manner best suited from the standpoint of economy, convenience and safety. The up-to-date merchant today is taking advantage of these appliances, so that we may in confidence look forward to a time when fires caused by careless handling of oils will be unknown. This will be brought about by various causes. The instinct of self-preservation is strong with everybody, and all must realize the risk in the careless handling of explosives. The fact that these safety appliances conserve the efficiency of the product, preserve the quantity intact and enable losses to be turned into profits brings enormous pressure to bear upon the thoughtful man. Public opinion, national and state safety boards will soon demand that every man will at least cease to menace his neighbor's property and his neighbor's life by unnecessarily lax methods in the handling of dangerous explosives.

The increasing prices of all kinds of oil and general economic requirements demand the proper storage and distribution of these liquids. Millions of dollars are lost annually due to the deterioration of the quality and waste in handling improperly stored oils. Hot and cut bearings, prematurely worn machinery, are very frequently due to deteriorated or contaminated oil. This enormous loss is usually never traced to the right source—poor oil storage. The same criticism can be made of improperly stored paint oils, varnishes, dryers, etc. Competition in practically all lines demands economical production; that means elimination of waste so far as possible in every department of the industry.

Your oils, etc., can be checked in as they are received and accurately recorded as they are used. You can keep just as accurate account of your oils as you can of your tools.

All railroads, mines or manufacturing institutions maintain stockrooms for the purpose of receiving and distributing all of the supplies used by the institution. This is considered absolutely necessary in order to reduce losses and to maintain a cost system.

Money is invested in oils just the same as any other supplies; yet it is a known fact that in most institutions no record is maintained as to the quantities received or dispensed. The purchasing, storing and the distributing of lubricating and paint oils, gasoline (petrol)), naphtha and other similar liquids is just as much a science and a part of the shop cost system as any other department.

Industrial plants of all kinds, especially railroads, are experimenting continually to learn how the cost of lubricating can be reduced and methods improved, forgetting apparently to investigate the oil house of the storeroom where the oils are stored and issued—the place where the percentage of loss is usually the greatest.

The installation of a modern storage system for oils, etc., need not necessarily imply the outlay of large sums. We have found this "big investment" idea on the part of men in charge of industrial institutions has frequently prevented them from considering the purchase of equipment. It is not always necessary, or even advisable, to put in at one time all the equipment the management might feel would be needed ultimately. In many instances storage is provided for those oils or other liquids which most urgently require it. The balance of the equipment can be added as finances permit or exigencies demand.

Modern Storage Systems

Modern storage equipment for handling liquids is really divided into two general types—one for handling volatile liquids, such as gasoline (petrol), naphthas, paint oils and varnishes, and the other for handling non-volatile liquids, such as lubricating oils.

The first of the two general types requires underground storage tanks for gasoline (petrol) or naptha, and above-ground storage for the paint oils and varnishes. This arrangement usually meets with the demands of the various state laws governing this type of storage. Where underground tanks are required, they should be cylindrical in design. If made of galvanized steel, all seams and rivets should be carefully made and then soldered inside and out. If heavy metal is used—much as three-sixteenths steel or heavier weights, as conditions or the capacity of the tank may make necessary—then all seams and rivets should be carefully calked. Storage tanks for volatile liquids require special care in construction. A tank may hold water or steam pressure, but it is usually unfit for volatile liquid storage purposes.

Pumps

Specially designed pumps of either measuring or non-measuring type are connected by pipe lines to tanks buried underground or inserted in the top of tanks for above-ground use. Accurate devices are provided on the measuring pumps for the delivery of desired quantities of liquids. Gear-driven meters may be added for the purpose of checking consumption. Locks are supplied on both types of tanks and on the pumps as well. This prevents unauthorized usage and theft.

Where a battery of individual units is used, barrel track and barrel drainers are used in connection with small chain hoists. This makes it very easy to handle the barrels and drain them completely into the manhole of the tanks. This saves labor, time and liquid and prevents the loss of liquid due to the return of liquid in barrels which have not been properly drained by the old style spigot method. Dirt, dust and sediment are kept from the liquids, fire danger is entirely eliminated, valuable storage space is saved, labor is lessened, cost and consumption are easily arrived at.

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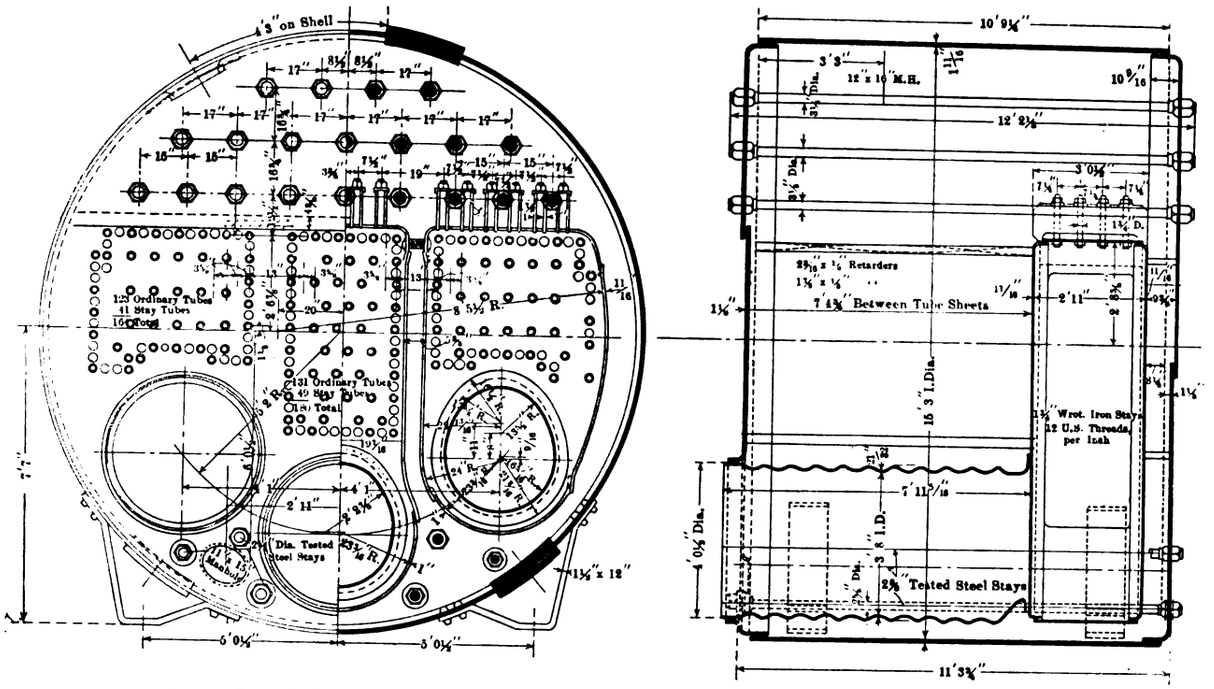

Fig. 1.—General Arrangement of Scotch Boiler as Used on Ships of the Emergency Fleet Corporation

Boilers of the New Emergency Fleet

Comparative Results Obtained with Scotch and Watertube Boilers—Relative Costs and Weights and Service Records—Details of Construction

BY JOS. J. NELIS*

BEFORE the world war the American merchant marine had for a number of years consisted of a very small proportion of the world's tonnage. Owing to its restricted size, operating engineers and designers were inclined to follow established foreign precedence as regards propelling equipment. Therefore, nearly all American merchant ships were fitted with Scotch marine boilers and triple expansion engines. This equipment, when properly handled by trained crews, gave satisfactory service as regards reliable operation. Reliability in operation is the most essential requirement of marine propelling equipment, but economy of operation, while desirable, has in the past been neglected owing to the conservatism of marine engineers in all countries.

The development of the watertube boiler in land plants has shown it to be considerably more economical than the firetube boiler, but it had not been adopted to any great extent by the American merchant marine. The Amreican navy, however, and practically all foreign navies, have adopted the watertube boiler almost exclusively on account of its lower weight, reduced size, greater economy and much greater capacity than the Scotch boiler.

Demand for Boilers Created by the War

When America entered the world war in 1917 the necessity for a larger merchant marine, which had been well known for a number of years by all naval and marine interests, was suddenly discovered by the rest of the country, as the necessity arose for transports for our troops and their supplies. The Government promptly formed an organization to build ships and also requistioned all the ships then building in the shipyards of the country. A review of the situation at that time showed that the requirements were so vast that it would be necessary to develop a number of new shipyards and to expand the American merchant marine tremendously in the shortest possible period of time.

This programme was handled for the Government by the Emergency Fleet Corporation, and at one time contracts had been entered into for more than 14,000,000 deadweight tons of shipping. This included both the requisitioned ships then building, which were taken over by the Government, and new contracts for ships made by the Emergency Fleet Corporation. Since the signing of the armistice this programme has been reduced approximately 20 percent.

It developed during the expansion period that it would be possible to produce hulls much faster than the propelling equipment, particularly if Scotch boilers and triple-expansion engines were to be used exclusively. It was, therefore, necessary to place orders for propelling equipment with all shops available, in order to prevent delay in fitting out hulls with propelling machinery after launching.

Emergency Fleet Requirements

As new ship contracts were being constantly made, propelling equipment was ordered in standard units and sizes in large quantities and later allocated to the various shipyards as their needs developed. The necessity for making advance contracts for large amounts of propelling machinery can be realized by the fact that in one day (July

* Manager marine department, Power Specialty Company, New York, and formerly senior marine engineer, boiler unit, engineering section, United States Shipping Board, Emergency Fleet Corporation.

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4, 1918) ninety-five hulls were launched, which required over 250 boilers. Contracts were entered into for all Scotch boilers that could be built in the time available by plants equipped for this work, and contracts were also

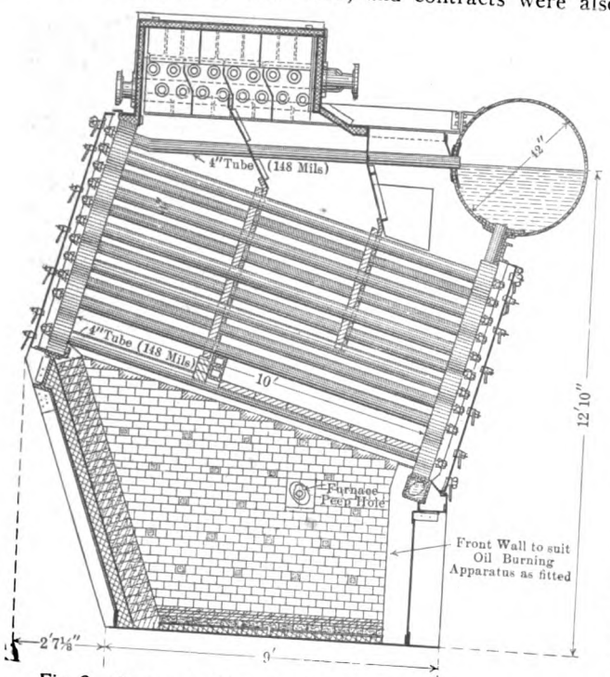

Fig. 2.—Section of Babcock & Wilcox Marine Type Boiler

entered into for new plants and the shop equipment required for the building of additional Scotch boilers; also about 50 percent of the total capacity of the country for the building of watertube boilers was used to produce boilers of this type. A large number of turbines were also ordered to supplement the engine-building capacity of the country. If the original programme of the Emergency Fleet Corporation had not been reduced there would have been a shortage of propelling equipment late in 1919, in spite of the fact that this equipment was ordered in excess of requirements shown by the ship contracts at any period. When the shipbuilding programme was reduced the propelling equipment contracts for these ships were canceled where manufacture had not been too far advanced. In other cases the propelling equipment was completed and stored for future use.

At the preesnt time the new emergency fleet, including both requisitioned and contract ships, without further cancellations or reinstatement of contracts, when completed will have in service approximately the following boilers:

WATERTUBE BOILERS

Type	Number
Babcock & Wilcox	
Emergency Fleet Standard	1,100
Foster	600
Heine	450
Badenhausen	185
Yarrow	65
Ward	64
Colvin	48
Scott	32
Wickes	30
Ballin	24
Howden	20
Craig	16
	4
	2,638

SCOTCH MARINE BOILERS

Size	Number
11 feet 0 inches to 11 feet 8 inches diameter	
12 " 0 " " 12 " 11 " " "	132
13 " 0 " " 13 " 11 " " "	46
14 " 0 " " 14 " 3 " " "	290
14 " 6 " " 14 " 8 " " "	175
14 " 9 " " 15 " 11 " " "	231
15 " 0 " " 15 " 3 " " "	665
15 " 4 " " 15 " 11 " " "	526
16 " 1 " " 16 " 6 " " "	150
	26
	2,241

Total boilers, 4,879

This tabulation shows approximately one-half the ships being built were fitted with Scotch boilers and a similar number with watertube boilers. Scotch boilers are being fitted principally in steel cargo ships and tugs. The designs of Scotch boilers used were prepared by shipbuilders for established shipyards and by the Emergency Fleet Corporation for the new shipyards. All of these boilers are of the more or less conventional design formerly used almost exclusively in merchant marine practice.

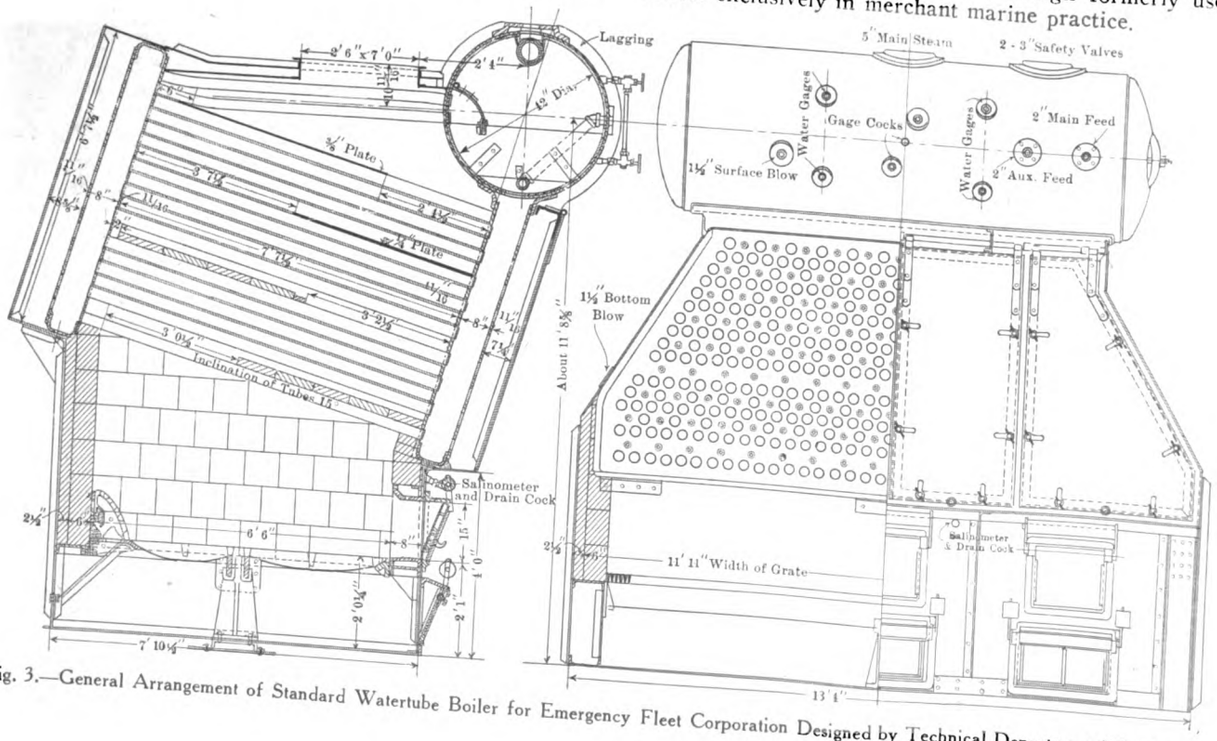

Fig. 3.—General Arrangement of Standard Watertube Boiler for Emergency Fleet Corporation Designed by Technical Department, Washington

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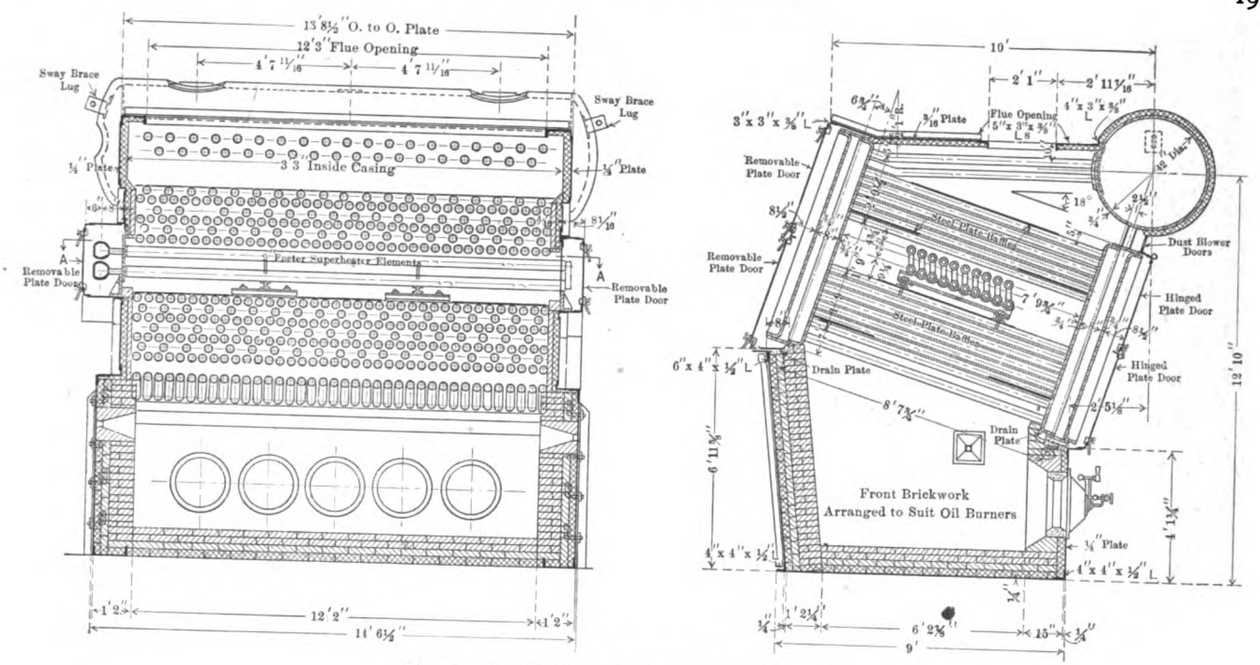

Fig. 4.—Cross-Section of the Foster Marine Boiler

SCOTCH BOILERS

To obtain as economical an arrangement as possible, the Scotch boilers for the emergency fleet were designed to give a ratio of heating surface to indicated horsepower of 3 to 1. For example, a considerable number of standard steel cargo ships were of approximately 8,800 to 9,400 deadweight tons and were equipped with three Scotch boilers built for 210 pounds working pressure, 14 feet 9 inches diameter by 11 feet long, having a total of 8,700 square feet heating surface. These boilers supplied steam to one triple-expansion engine with cylinders 24½ inches, 41½ inches and 72 inches diameter by 48 inches stroke, rated at 2,800 indicated horsepower at 88 revolutions per minute.

The steam consumption of a ship of this type is approximately 45,000 pounds per hour for all purposes. The steam requirements per boiler are therefore 15,000 pounds of steam per hour, equal to an evaporation of slightly more than 5 pounds per square foot heating surface per hour. Under these conditions the average trial trip data of a number of ships showed that the temperature of the gases leaving the boiler averaged 650 degrees F. This was reduced 100 degrees by the waste heat type superheater located in the uptakes above the boiler tubes and further reduced 75 to 100 degrees by the heated forced draft air tubes, giving a final stack temperature of 450 to 475 degrees F. The installation of the waste heat superheater and air heater tubes resulted in giving much greater fuel

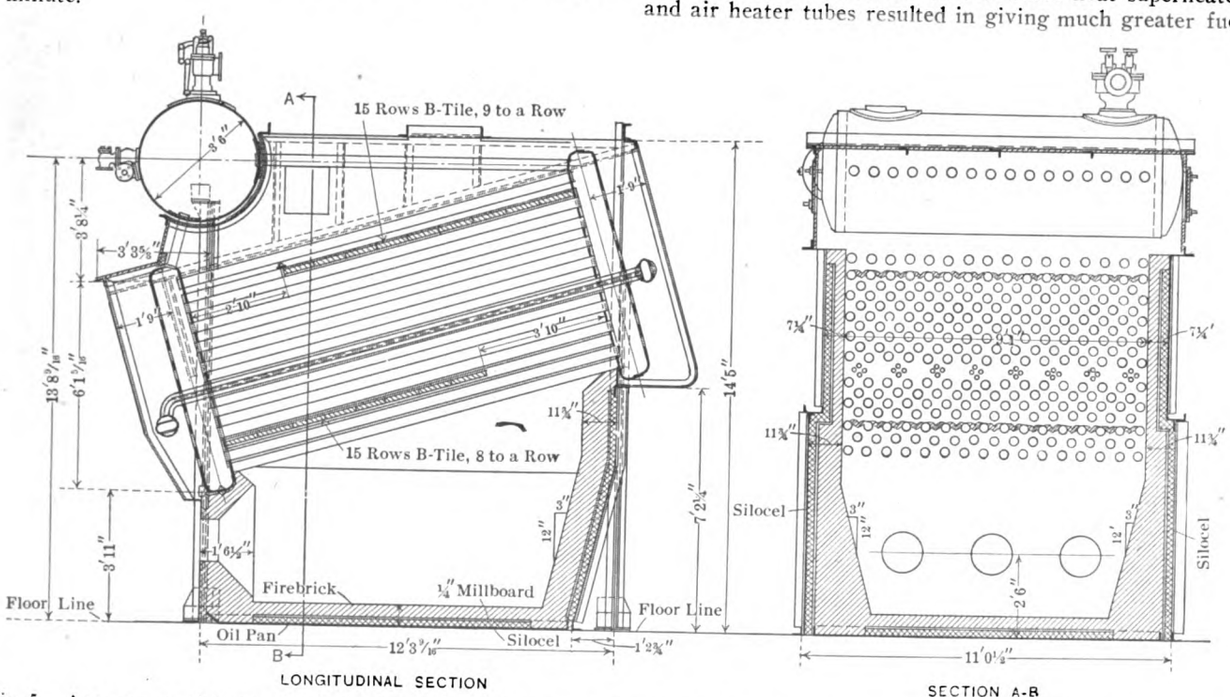

Fig. 5.—Arrangement of Setting for Heine Safety Boiler Built for the Emergency Fleet Corporation. This Boiler Has a Heating Surface of 3,170 Square Feet

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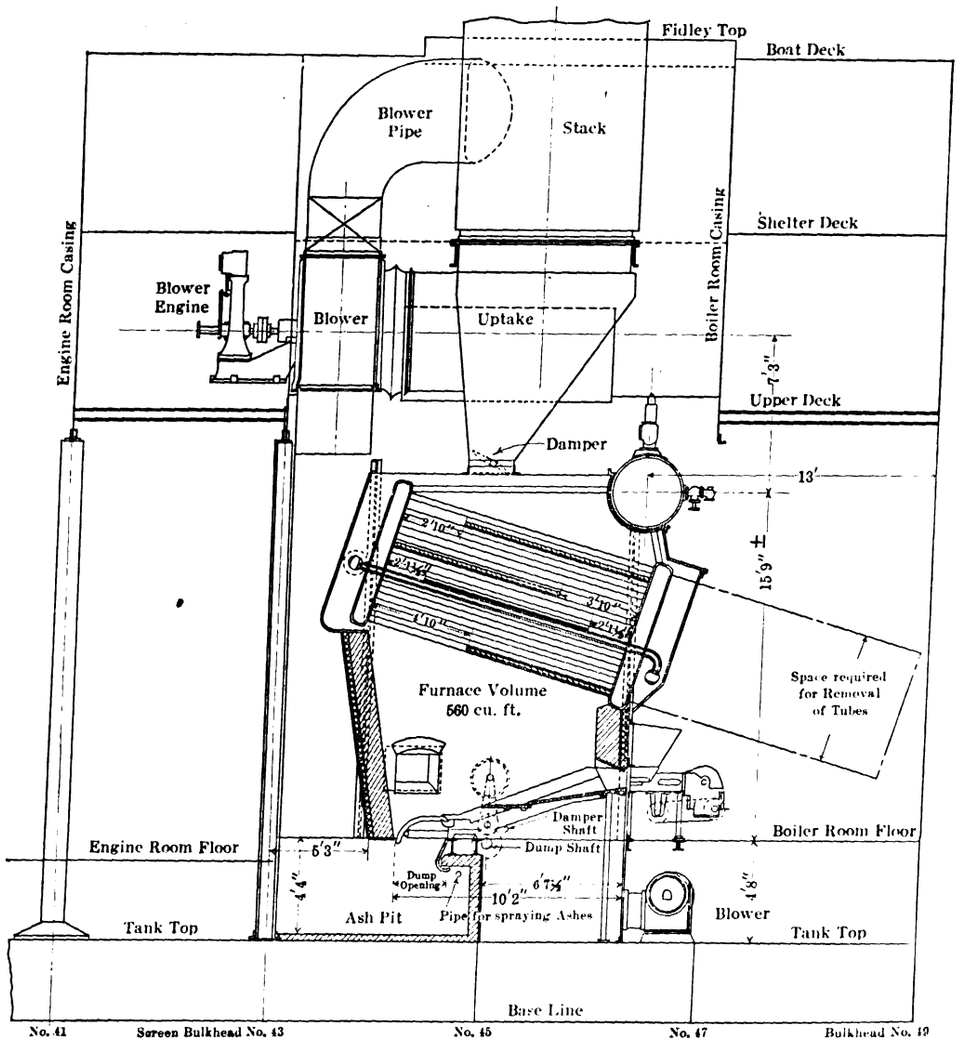

Fig. 6.—Arrangement of Riley Stokers Under Heine Marine Boilers as Contracted for by the United States Shipping Board Emergency Fleet Corporation

economy than was formerly obtained in Scotch marine boilers not fitted with these devices. With this arrangement the economy of the Scotch boiler, its superheater and air heater, closely approximates that of the average watertube boiler.

Weights of Scotch and Watertube Boilers

Ships for the merchant marine are primarily designed to carry cargo, and any unnecessary weight in the propelling equipment reduces the cargo-carrying capacity of the ship. The Scotch boiler is at a serious disadvantage compared with the watertube boiler as regards weight. A comparison of these two types of boilers, both built for 225 pounds working pressure, is as follows:

	Scotch	Watertube
Heating surface.....	2,500 square feet	2,500 square feet
Size of boiler.....	14 feet 6 inches by 11 feet	42-inch cross drum
Weight of metal.....	120,087 pounds	45,991 pounds
Weight of brickwork and baffles.....	.....	15,160 pounds
Weight of insulation.	5,364 pounds	840 pounds
Weight of water.....	45,048 pounds	17,000 pounds
Total	170,499 pounds	78,991 pounds

The weight given for the Scotch boiler does not take into consideration the weight of the heated forced-draft system, and superheaters which are necessary for a boiler of this type if reasonable fuel economy is to be obtained or the extra weight of boiler foundations and saddles.

An analysis of the weights of sixty representative Scotch boilers made by different manufacturers shows that this averages from 60 to 70 pounds per square foot heating surface when built for 210 pounds working pressure. The weight of any Scotch marine boiler can be very closely calculated by the following formula:

W = diameter^2 × L × P × .22 × 1.05 = tons of 2,000 pounds.
.22 = factor.
1.05 = manufacturers' allowance for overweight of material.
Diameter = inside diameter in feet.
L = overall length in feet.
P = working pressure in pounds per square inch.
W = total weight in tons without water.

The weight of the water in the Scotch boiler is usually more than double the weight of the water in the watertube boiler. This additional weight of water allows a steadier lower level to be carried and gives a larger reserve in case of trouble with feed pumps, but also seriously reduces the weight-carrying capacity of the ship.

The design of Scotch boilers has become so standardized by the rules and regulations of classification societies of the United States Government, and past experience, that all shipbuilders followed closely these rules. This is clearly shown by Table 1, giving in detail the construc-

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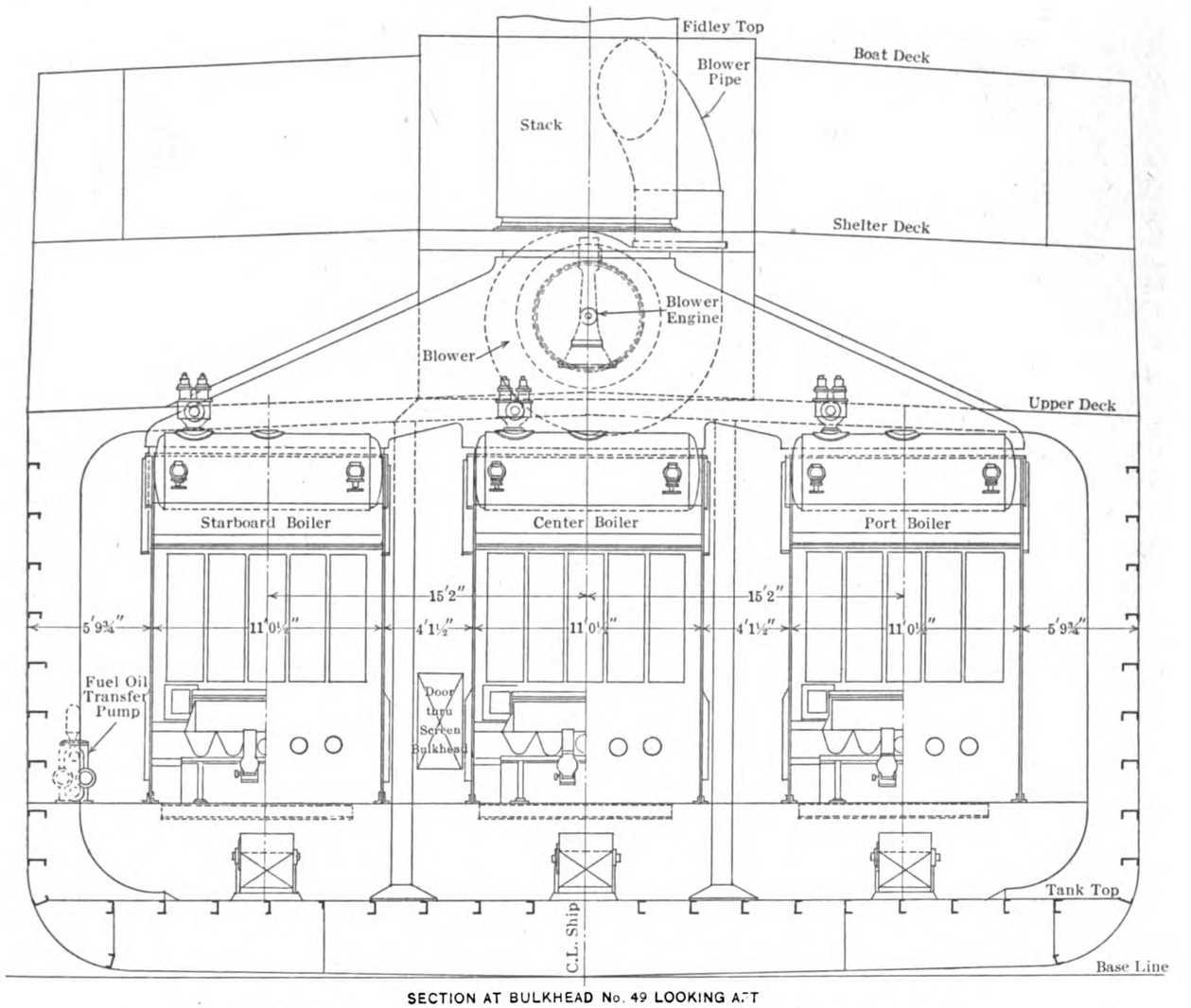

Fig. 6a.—Section Through Boiler Room of Vessel Equipped with Riley Stokers Under Heine Boilers

tion, pressure, weight, areas, and dimensions of nine Scotch boilers designed by the Emergency Fleet Corporation and five Scotch boilers designed by the leading shipbuilders. Fig. 1 shows a representative Emergency Fleet boiler as used in steel cargo ships. All the designs are for single-ended boilers. The majority of them are of the three-furnace type. It has been found from past experience that double-ended boilers require considerable repairs and are short lived. It is therefore more economical in cargo ships where small power is required to use single-ended Scotch boilers, although this requires additional space in the ship, at a moderate evaporation rate, to secure long life and a minimum of repairs.

Service of the Scotch Boiler

The Scotch marine boiler has, in the past, given satisfactory service, due to its manufacture having been in the hands of experienced shipbuilders and its operation in the hands of experienced marine engineers. When well built, well designed and well operated by a trained crew, with not less than one-third of its area for steam space it will give satisfactory service and will stand a considerable amount of salt feed without priming troubles, but, due to its defective circulation and the different expansion of its various parts at working pressure and temperature, the repairs required are considerable. This is particularly true of ships in the coastwise service on short runs where the boilers are alternately heated and cooled much oftener than on long ocean voyages. In many cases the time required for annual repairs to a ship is governed by the time required for repairs to Scotch boilers, as these boiler repairs require more time than other annual repairs of the ship.

In many cases Scotch boilers at sea when carrying pressures from 180 to 210 pounds have been found with the bottom of the shell at not over 100 degrees F. This is due to the lack of circulation and to the bottom of the boiler not usually being insulated. A great number of devices have been patented and tried out for circulating the water in Scotch boilers, but as none of them has been used for any length of time, it is evident that no successful method of securing the necessary circulation has yet been found.

Due to nearly all merchant ships being fitted with this type of boiler in the past, practically all American and foreign ports were equipped with shops who specialized in the necessary repairs and boiler scaling required when a ship was in port.

Repairs to Scotch Boilers

At the present time a number of Scotch boilers have been installed in the new emergency fleet which are not

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TABLE I.—MAIN PARTICULARS OF SCOTCH BOILERS IN THE EMERGENCY FLEET

Drawing Number	Diameter of Boiler	Length of Boiler	Square In. Working Press.	Length of Grate	Square Ft. Area of Grate	HEATING SURFACE					H. S.	G. A.	Cu. Ft. Volume Steam	Lbs. Weight Wet	Lbs. Weight Dry	Number, Size, Kind and Thickness of Tubes		
						Tubes	Furnace	Com. Cham	Total		G. A.	T. A.				Stay	Common	Total
E-15000	15′-3″	11′-3¾″	210	6′-8″	73.	2459	150	260	2869	Coal	39.3	6.08	480	187490	131740	131-2½″-No.2 B. W. G.	377-2½″ No. 10 B. W. G.	508
E-15002	14′-9″	11′-0″	210	5′-6″	60.3	2459	270	321	3050	Oil								
E-15003	14′-6″	11′-7⁹/₁₆″	210	5′-6″	60.5	2331	146	273	2750	Coal	45.5	4.8	380	190126	118930	125-2½″-⁵/₁₆″ Thick	367-2½″- No. 10 B. W. G.	492
E-15004	14′-6″	11′-7⁹/₁₆″	210	5′-6″	60.5	2331	262	342	2935	Oil								
E-15005	14′-6″	12′-0″	155	6′-3½″	70.78	2116	152.3	260.2	2528.5	Coal	41.8	5.54	419			102-2½″-⁵/₁₆″ Thick	322-2½″ No. 10 B. W. G.	424
E-15006	14′-6″	11′-7⁹/₁₆″	190	5′-6″	60.5	2116	275	322	2713.	Oil								
E-15007	11′-6″	12′-0″	180	6′-5½″	48.3	1952.3	152.3	253.5	2358.1	Coal	39	4.79	407	165900	117500	124-3″-¼″ Thick	202-3″ No. 10 B. W. G.	326
E-15008	13′-0″	11′-0″	190	6′-3″	50.	1952.3	272.3	315.5	2540.1	Oil								
E-15009	52″	96″ High	100	3′-8½″D	10.8	2121	169	234	2524	Coal	35.7	5.38	348	141300	94700	82-3″- No. 5 B. W. G.	252-3″-No. 10 B. W. G.	334
Newport News 85878	15′-3″	11′-3¾″	210	6′-8″	73.	2121	305	304	2730	Oil								
Sun. S. B. Co. 26-862-1	15′-3″	11′-5″	190	5′-6″	61.8	1951	153	254	2358	Coal	39	4.8	410			124-3″-¼″ Thick	202-3″-No. 11 B. W. G.	326
Beth. S. Co. E-1376-35-1	14′-2″	11′-10″	190	5′-0″	55	1951	273	316	2540	Oil								
Newport News 73998	15′-9″	11′-5″	220	5′-4½″	71²/₃	1241	124	157	1522	Coal	31.5	6.86	142	105400	68700	40-3″-No. 5 B. W. G.	138-3″- No. 10 B. W. G.	178
Union I. Wks. 25546	15′-6″	12′-1″	220	6′-0″	67.5	1241	225	186	1652	Oil								
						1626	109	179	1914	Coal	38.3	5.86	312			72-2½″-⁵/₁₆ Thick	252-2½″ No. 11 B. W. G.	324
						1626	200	219	2045	Oil								
						266	67.5		333.5		30.8	4.596	...			2-2″-No. 7 U. S. S.	126-2″- No. 13 U. S. S.	128
						2459	150	260	2869	Coal								
						2459	270	321	3060	Oil	39.3	5.66	470			134-2½″ No. 2 B. W. G.	374-2½″ No. 10 B. W. G.	508
						2329.5	164	283.6	2777	Coal	44.9	5.2	445		117756	1 222½″-¼″ Thick	341-2½″ No. 10 B. W. G.	463
						2050	187	238	2475	Coal	45	5.6	347			110-2½″-⁵/₁₆″ Thick	276-2½″-.120″ Thick	386
						2336	212	352	2900	Coal	40.5	5.43	440	198400	141600	124-2¾″-⁵/₁₆″ Thick	302-2¾″- No. 10 B. W. G.	426
						2600	167	265	3032	Coal						19-5″-¼″ Thick		
						2600	300	325	3225	Oil	45.	5.08	444	190900	125000	103-2½″-5¼″ Thick	339-2½″-No. 9 B. W. G.	361

Drawing Number	Distance Between Tube Sheets	Square Ft. Area Thru Tubes	% of Dia. Top of C.C. from C.of B	Size of Safety Valve	C. of B. to Top of C. C.	Hour Lbs. WaterEvap per Sq. Ft. of Grade	THIGNESS PLATE				FURNACE						COMBUSTION CHAMBERS					
							Shell	Front Head	Back Head	Butt Straps	Inside Dia.	Outside Dia.	Type	No.	Thick-ness	Length	Depth Inside	Greatest Width	Height	Front	Top	Back	Wrap-per
E-15000	7′-4¼″	12.	32	2-3½″	2′-8³/₈″	270	1¹¹/₁₆″	1³/₁₆″ 1¹/₈″	1³/₁₆″ 1¹/₈″	1⁵/₁₆″ 0 1⁵/₁₆″ 1	3″											
E-15002	7′-2⁷/₈″	12.49	34	2-3½″	2′-11½″	270	1⁵/₈″	1⁹/₃₂″ 1⁹/₁₆″	1⁹/₃₂″ 1¹/₁₆″	1¾″	3′-8″	4′-0⅝″	Str. Mouth Morrison	3	²¹/₃₂″	7′-11¹³/₁₆″	2′-11″	C 3′-3½″ S 4′-7″	9′-5″ 7′-5″	¹³/₁₆	⅝	¹¹/₁₆	1″
E-15003	7′-7½″	10.92	31.07	2-3½″	2′-8¾″	270	1⁹/₃₂″	1⁹/₃₂″ 1¹/₃₂″	1⁹/₃₂″ 1¹/₃₂″	1¾″ 1⁷/₃₂″	3′-8″	4′-0⅝″		3	²¹/₃₂″	7′-9½″	2′-10″	C 3′-0″ S 4′-11″	9′-3″ 7′-3″	¹³/₁₆	¹¹/₁₆	¹¹/₁₆	¹⁵/₁₆
E-15004	7′-7½″	12.62	30.5	2-3½″	2′-9⅜″	270	1¹⁹/₃₂″	1¹/₃₂″	1¹/₃₂″	1⁷/₃₂″	3′-8″	4′-0⅝″		3	²¹/₃₂″	8′-2¼″	2′-10″	C 3′-1″ S 4′-8″	9′-6″ 7′-6″	¾	¹¹/₁₆	¾	¹⁵/₁₆
E-15005	8′-11¹/₁₆″	13.17	27.9	4½″	3′-1¾″	180	1³/₁₆″	1″ 7/8″	1″ 9/16″	⅞″	3′-8″	4′-0⅝″		3	²¹/₃₂″	8′-2¼″	2′-10″	C 7′-8″ S 9′-9″	9′-9″ 7′-8″	²⁷/₃₂	¹¹/₁₆	¾	¹¹/₁₆
E-15006	7′-7½″	12.6	30.5	2-3½″	2′-9⅜″	270	1⁷/₁₆″	1¹/₃₂″ 29/32″	1¹/₃₂″ 31/32″	1¹/₈″	2′-10″	4′-2¹/₁₆″		3	¹⁷/₃₂″	8′-7¼″	2′ 10½″	13′ 8″	10′-0″	¹¹/₁₆	⅝	⅝	⅝
E-15007	8′-10⅝″	7.04	25.7	2½″ Du.	2′-8¾″	180	1³/₃₂″	15/16″ 7/8″	15/16″ 9/16″	13/16″	3′-8″	4′-0⅝″		3	¹⁹/₃₂″	8′-2¾″	2′-10″	C 3′-0¾″ S 4′-5¹/₈″	9′-9″ 7′-8″	¹³/₁₆	⅝	²¹/₃₂	⅞
E-15008	7′-8″	8.49	30.7	2-3″	2′-5³/₈″	250	1⁵/₁₆″	1¹/₁₆″ ¾″	1¹/₁₆″ ⅝″	1″	3′-9⅞″	4′ 2¹/₁₆″		2	¹⁹/₃₂″	9′-4½″	2′-3½″	5′-1″	7′-3″	¹¹/₁₆	⅝	⅝	⅝
E-15009	54″	2.35	...	2″	....	....	5/16″	7/16″	....	....	4′-0″	4′-4¼″		2	²¹/₃₂″	8′-3″	2′-3″	5′-4″	7′-6″	¹¹/₁₆	1¾	⅝	1³/₃₂
Newport News. 85878	7′-4¾″	12.9	32	....	2′ 6⅞″	....	1¹¹/₁₆″	1³/₁₆″	1³/₁₆″	1⅝″	3′-9¾″	.....	.....	..	.....	.....	.....	.....	.....	..	..	..	....
Sun. S. B. Co. 26-862-1	7′-8¼″	11.9	30	3½″ Twin	2′-11⅞″	270	1¹⁵/₃₂″	1¹/₈″ 1″	1³/₈″ 1″	1³/₁₆″ 0 1⁵/₁₆″ 1	3′-8″	4′-0⅝″	Str. Mouth Morrison	3	²¹/₃₂″	7′-11³/₈″	2′-11″	3′-4″ 4′-9″	9′-4″ 7′-8″	¹³/₁₆	⅝	¹¹/₁₆	1″
Beth. S. Co. E-1376-35 1	8′-1½″	9.81	27	3½″ Dup.	3′-1¼″	200	1³/₈″	1¹/₈″ ¾″	1¹/ ″ ¾″	1¼″	3′-9″	4′-1¾″		3	⅝″	8′-3¾″	2′-11″	3′-1″ 4′-10″	9′-10″ 7′-9″	¾	⅝	¾	¹⁵/₁₆
Newport News 73998	7′-7¹³/₃₂″	13.2	.285	3½″ Twin	3′ 4″	235	1⁴³/₆₄″	1¹/₈″ 29/32	1¹/₈″ ¾″	1⁹/₃₂ ″ 0 1¹⁹/₃₂″ 1	3′-8″	4′-0¼″	"	3	⅝″	8′-8⅝″	2′-9″ 3′-0″	2′-9″ 4′-9″	9′-4″ 7′-10½″	¾	⅝	⅝	⅞
Union I. Wks. 25546	8′ 2″	13 28	.282	....	3′-4½″	.....	1²¹/₃₂″	19/32″ 15/16″	19/32″ 15/16″	1¼″ 0 1½″ 1	3′-4″	3′-8¼″	"	4	⅝″	8′-2⁹/₁₆″	2′-10″	C 2′-4″ 2 S 4′-3″ 2	9′-10″ 2 7′-1″ 2	¹³/₁₆	²¹/₃₂	²¹/₃₂	¹⁵/₁₆
											3′-9″	4′-1⁵/₈″	Flanged Morrison	3	¹¹/₁₆″	8′-5³/₈″	2′-11″	C 3′-1″ S 5′-3″	10′-1½″ 7′-10″	⅞	²³/₃₂	²³/₃₂	1

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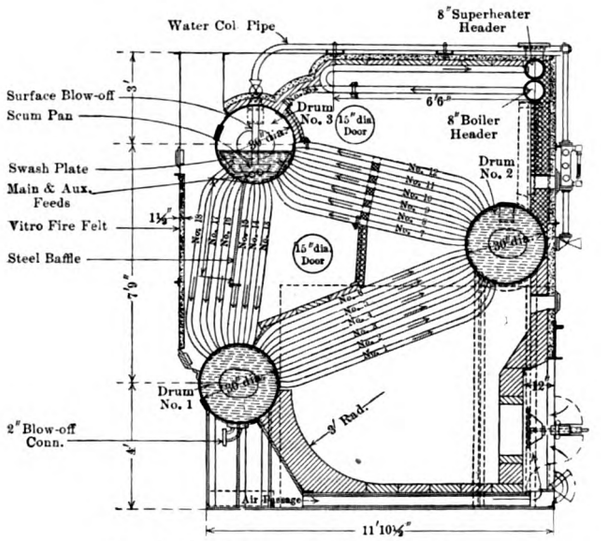

Fig. 7.—Badenhausen Setting, Elevation

operated by trained crews, and in some cases have not been properly built. As a result, repairs to Scotch boilers in these ships have been excessive. Practically 80 percent of the boiler repairs on vessels of the emergency fleet that are now in operation are being made on Scotch boilers, although only 50 percent of the boilers in operation are of this type. In many cases leaks due to poor workmanship of Scotch boilers cannot be made tight by the usual calking, and various kinds of welding have been resorted to. Welding, even when properly done, does not keep seams of Scotch boilers tight more than four or five years, due to the constant movement of these seams. When welding is not properly done it is the source of more trouble than the original leak.

In one recent case an inexperienced crew raised steam in Scotch boilers in less than four hours without circulating the boiler water. As a result the ship was laid up for a considerable length of time to weld and calk the major portion of the shell and combustion-chamber seams. The cost of these repairs on Scotch boilers, coupled with the increased first cost and the short life as compared with watertube boilers, makes the final cost of Scotch boilers for marine use excessive.

In some Scotch boiler designs, principally on requisitioned ships, which were building before the Emergency Fleet took charge, an attempt has been made to install too much heating surface for the diameter of shell used, with the result that the steam space is considerably less than one-third of the total shell area and the boilers, if slightly salted, prime badly. This design also makes it difficult, if not impossible, to scale the furnace crowns and properly clean the other parts of the boiler.

Forcing Scotch Boilers Uneconomical

In some ships an attempt has been made to use Scotch boilers at an evaporation of from 6 to 7 pounds per square foot heating surface. This evaporation can be maintained with oil fuel, but it results in a very uneconomical boiler, due to its extremely high stack temperature. It is also an expensive boiler to operate, due to the repairs required and the very short life of the boiler when operated at this excessive evaporation rate for a boiler of this type. In other cases Scotch boilers have been installed for an evaporation of approximately 4 pounds per square foot heating surface. This, while resulting in an efficient boiler, will give an increased weight of over 200 tons per ship on a 10,000 deadweight ton ship. Its repair cost will be low and its life considerably lengthened, but the increased weight makes it an expensive boiler for the shipowner, due to the space and weight required, resulting in a loss of cargo-carrying capacity.

The majority of the watertube boilers installed in the emergency fleet are of the well-known cross-drum, straight-tube type, which has given successful service both in the navy and merchant marine in the past.

Watertube Boilers

The watertube boilers for the steel ships were principally oil-fired, as it was generally recognized by marine engineers that the watertube boiler is better fitted to withstand oil-firing than the Scotch boiler. Watertube boilers were also almost exclusively used in the wood ships, and were designed for coal-firing, as it was not

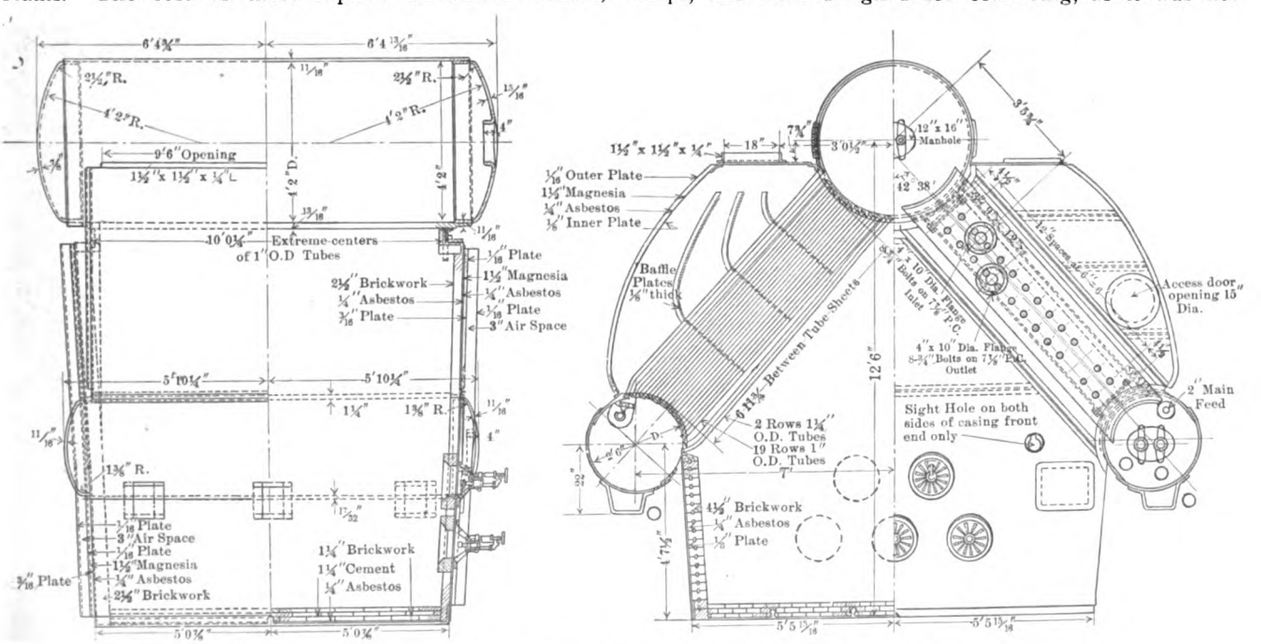

Fig. 8.—Arrangement of Yarrow Boiler Built by Bethlehem Shipbuilding Corporation

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considered advisable to make these ships oil burners. The watertube boilers used in the wood ships were of the Emergency Fleet standard design and were built by various manufacturers under the supervision of the Emergency Fleet inspection service.

It was necessary, however, to accept and use in the wood ships a number of other watertube boiler designs which had not been successfully developed for marine practice. Most of these boilers are not satisfactory for marine use.

Babcock and Wilcox Watertube Boiler

The Babcock and Wilcox boiler, Fig. 2, designed especially for use in the Emergency Fleet Corporation cargo ships, is a special large tube design and is a modification of the same boiler as used in land practice. This boiler, while not as efficient as the Babcock and Wilcox standard small tube marine boiler, has a larger furnace volume, larger gas passages, more water storage and is fitted with more than the usual number of oil burners. The result is an easy steaming boiler that can be readily cleaned, and which is more economical than the average Scotch marine boiler,

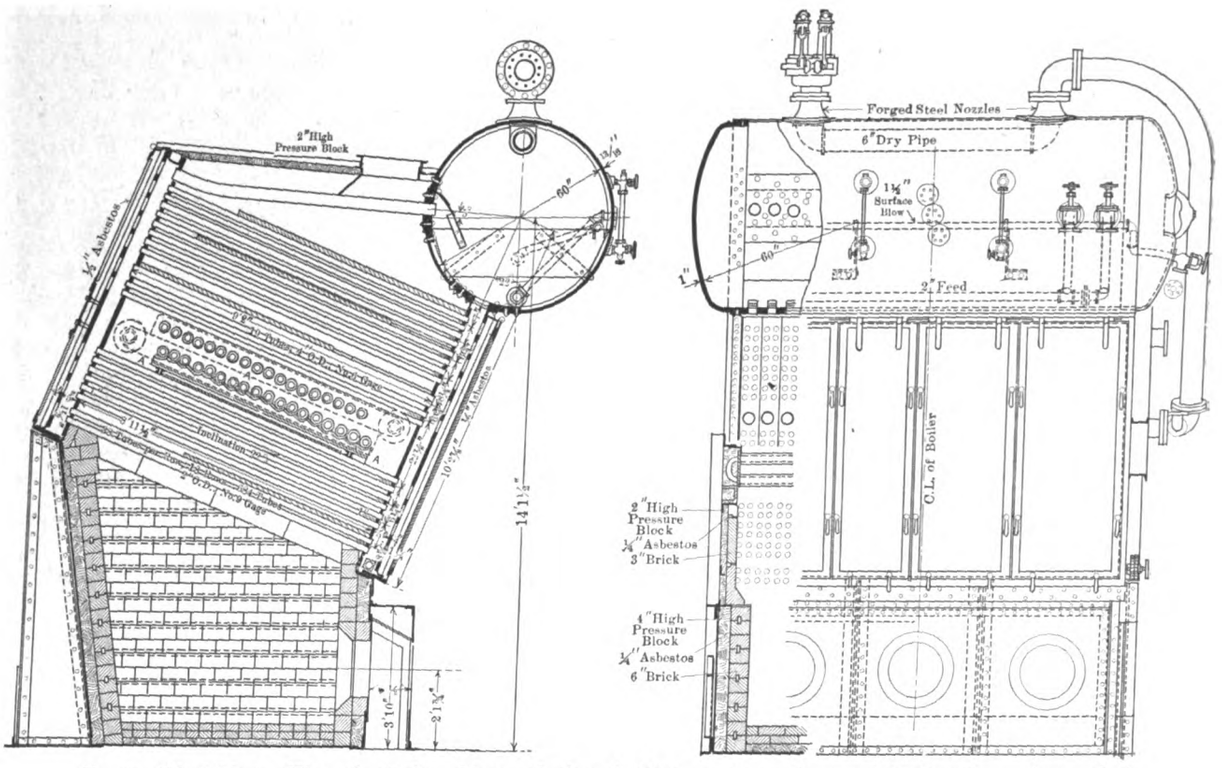

Fig. 9.—Ward Marine Watertube Boiler. Heating Surface, 3,500 Square Feet; Pressure, 300 Pounds per Square Inch

Emergency Fleet Standard Watertube Boiler

The Emergency Fleet standard watertube boiler was designed to obtain the maximum grate area to enable it to give sufficient steam when operated by inexperienced firemen using poor coal with natural draft. Later, induced draft fans were fitted, but are not used except with very poor coal. This boiler follows the conventional cross-drum marine design. The headers are of staybolted construction with closer tube spacings than were formerly used in marine practice, which, with the four horizontal baffles, has resulted in a satisfactory, economical, as well as a high capacity boiler. Fig. 3 shows the design of this boiler. It will be noted that the rear of grate is fitted with Wager bridge wall, which has proved very successful in practice by allowing excess air at the rear of furnace to assist proper combustion of the furnace gases and in preventing clinkers adhering to the rear brick wall of the furnace.

These boilers are used exclusively in wooden ships, which are generally operated by the younger and more inexperienced engineers. Notwithstanding this handicap, they have in a majority of cases shown remarkable records for reliability and economy, capacity and low cost of repairs. As an evidence of the care these boilers have been compelled to operate under, in two of the wooden ships the boilers have been heavily fired until all the water has been evaporated and the lower tubes melted. In neither case did an explosion occur due to the water having been completely evaporated. These burned-out boilers were replaced by new boilers of the same type.

Foster Watertube Boiler

The Foster watertube boiler, Fig. 4, is also of the conventional cross-drum, horizontal, straight-tube type. Its essential features are the close tube spacing, steel baffles and the location of the superheating chamber, which alows any degree of superheat to be obtained that may be required for either marine engines or turbines. The close tube spacing and arrangement of baffles insure the greatest possible economy. The steel baffles are more satisfactory than brick baffles, which have been found difficult to keep tight and therefore need constant repair. The headers are of staybolted construction and have an unusually large capacity for water storage, insuring steadier water level than is usually found in boilers of this type.

Heine Marine Watertube Boiler

The Heine boiler, Fig. 5, is also of the cross-drum, straight-tube type and is a modified form of their land boiler. The tubes are longer than is customary in marine

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work, which results in a long, narrow furnace not suitable for coal firing. This narrow furnace, when oil fired, results in considerable furnace brickwork repairs. This boiler, owing to the restricted furnace width, is, however, well adapted to stoker firing. An arrangement of stokers, as shown in Fig. 6, was prepared by the Emergency Fleet for these boilers, but after the armistice, owing to the lower price of oil fuel, nearly all ships were arranged for oil-burning and these stokers were not installed.

Watertube boilers are the only marine type that can be adopted for stoker firing. When the price of coal reaches a point at which it will again be used extensively in marine practice it is evident that stokers of this type or a similar design will be used, as these boilers can then be operated at the same capacity and economy now attained with oil fuel, which is not possible when hand fired by the character of labor available for marine firing.

BADENHAUSEN BOILERS

The Badenhausen boiler, Fig. 7, is a distinct departure from the conventional marine watertube boiler, as it uses a large curved tube design with practically no modifications from the land boiler of this type, except the small upper steam drum and steel casing. Boilers of the curved tube type have given very satisfactory operation in land plants and have been used extensively in naval practice, but with tubes of smaller diameters.

YARROW EXPRESS TYPE BOILER

The Yarrow boiler, Fig. 8, is the well-known express type as used in naval work. The Emergency Fleet ships being fitted with this boiler were originally intended for transports, and will now be used for passenger ships. These boilers are admirably suited for high-powered vessels of this type. No Yarow boilers are being fitted in slow-speed, low-powered cargo boats.

WARD BOILERS

The Ward boiler, Fig. 9, is also of the cross-drum, horizontal, straight-tube type. Its essential features are the position and location of the horizontal baffles and the method of manufacturing the headers, which gives the circulation of the sectional header boiler without the use of staybolts. It will be noted that this boiler is fitted with an exceptionally large steam drum, but as the headers are small the amount of water contained in the boiler is not greater than is usually found in boilers of this type.

THE COLVIN BOILER

The Colvin boiler, Fig. 10, is of the curved-tube, three-drum type, somewhat similar to the express type of boiler, and is fitted with 1½-inch tubes. The essential difference

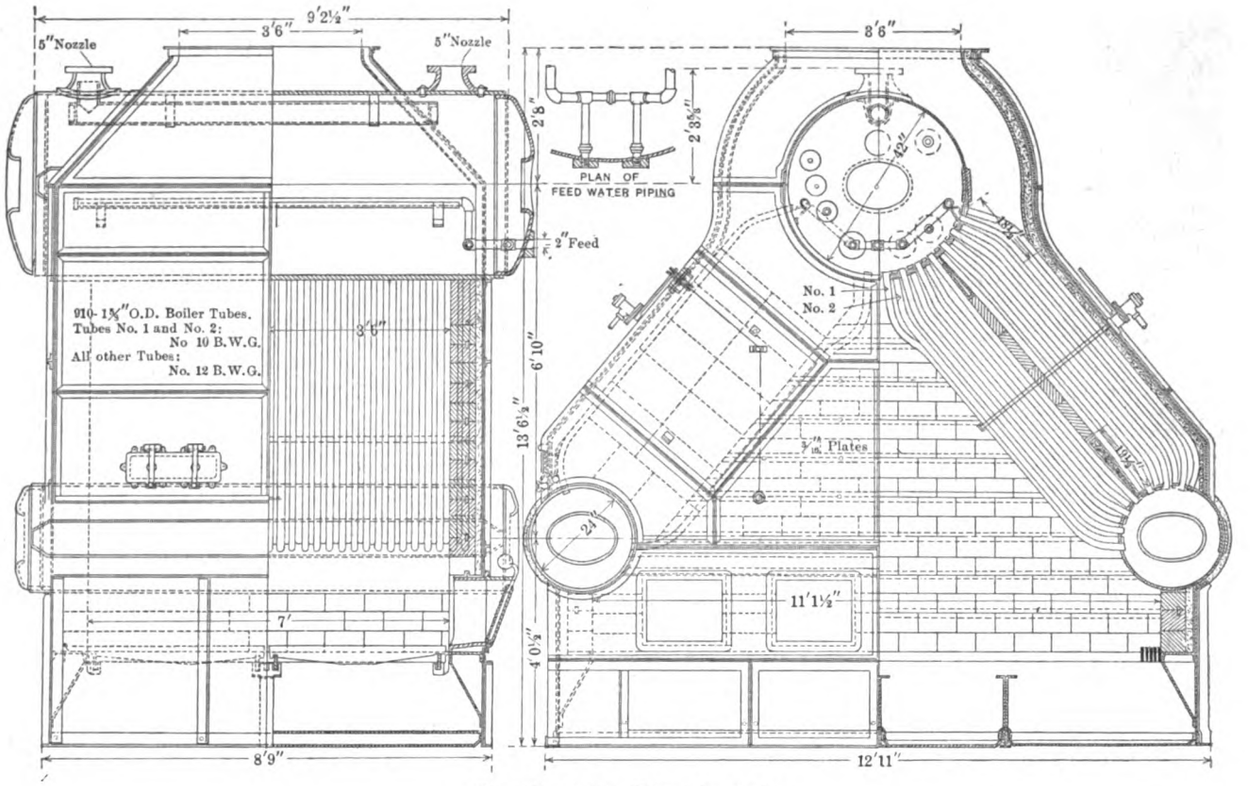

Fig. 10.—Colvin Watertube Boiler

of this boiler from standard designs is the arrangement of baffling with the addition of a steam soot blower. This soot blower enables the operator to keep the tube surfaces clean. Soot blowers are now standard on practically all land boilers, and it is expected that they will be used on all marine boilers in the near future.

THE SCOTT BOILER

The Scott boiler, Fig. 11, is also of the curved-tube, three-drum type. This boiler has little, if any, baffling and depends practically on the tube spacing for its economy. Its casing insulation has not proved sufficient for merchant marine service.

THE WICKES BOILER

The Wickes boiler, Fig. 12, is of the cross-drum, horizontal, straight-tube type, with a combination of horizontal and vertical baffles similar to other well-known boilers. Its essential feature is the method of manufacturing the headers, which can be completely machine riveted and have

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no joints in the fire. This boiler was used on small steel lake vessels exclusively.

Watertube Boilers of Radical Design

The Ballin boiler, Fig. 13, is a radical departure in design from previous successful watertube boilers. It was used on wood and composite types of ships. Its essential features are the long, narow furnaces and the small amount of grate surface for the heating surface installed. The furnace gases do not cover all of the heating surface, resulting in high stack temperatures. This boiler also has a very restricted water circulation. It has not proved satisfactory in service and is being replaced in some cases with Emergency Fleet standard watertube boilers.

The Howden boiler, Fig. 14, is a British type of a radically different design from previous successful marine watertube boilers. Its essential features are the lack of furnace volume, the short gas passage through tubes and the larger lower drum sheet over the fire, where scale deposits and causes rapid burning out of this sheet. This boiler has not proved successful in marine service, especially when oil-fired, and is now being replaced by boilers of the cross-drum, horizontal, straight-tube watertube type.

The Craig boiler, Fig. 15, is also a departure from previous successful marine watertube boilers. Its essential features are the lack of furnace volume and the sectional header construction, using the downflow principle, which was formerly tried out in land practice without success. This boiler was fitted in two ships, neither of which has given satisfactory operation.

Results Obtained with Watertube Boilers

The watertube marine boiler, as shown by the various designs being built and operated by the Emergency Fleet, is capable of being built in a great number of different designs. The most successful watertube boilers in the merchant marine are those of the conventional cross-drum, horizontal, straight-tube type. Boilers of this type built by reliable manufacturers now in service in the Emergency Fleet are giving entire satisfaction as regards reliability, economy, capacity and cost of upkeep. This type of boiler, however, due to the limited water storage and small steam space, requires more careful water tending than the Scotch marine boiler.

With the proper water tending and reasonable care in operation this boiler, when well built, should give satisfactory service for a much longer period of years than the Scotch boiler. Owing to its rapid, well defined circulation it is more likely to prime when salted, due to a leaky condenser or improper operation of the evaporator, than the Scotch boiler, with its larger body of water and defective circulation. If the tubes are kept clean internally there will be practically no boiler repairs excepting the necessary renewal from time to time of the furnace brickwork.

The majority of these boilers are not fitted with sufficient furnace insulation to keep the steel casings reasonably cool. This is a result of trying to adapt naval practice in merchant marine work where weight is not so important. With the proper furnace insulation, such as is installed in the Foster boiler, the furnace steel casing temperatures will not exceed that found with well-insulated Scotch boilers.

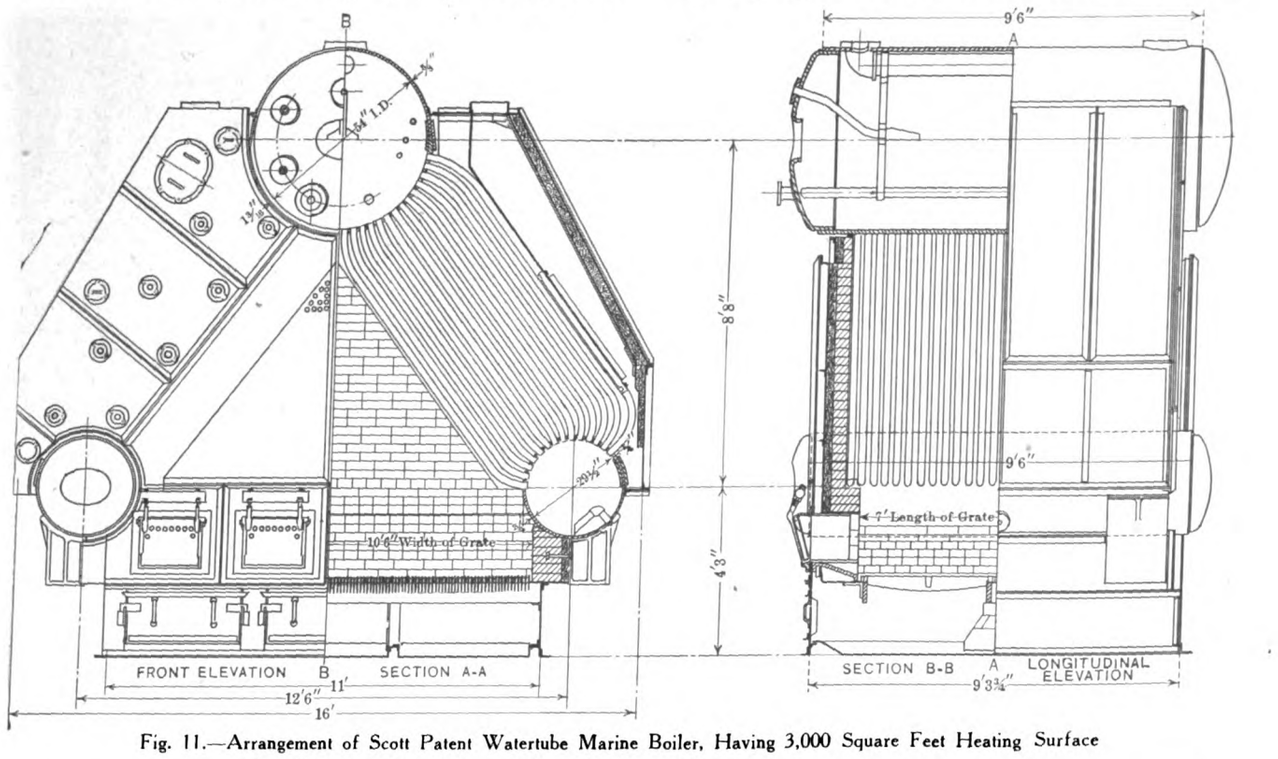

Fig. 11.—Arrangement of Scott Patent Watertube Marine Boiler, Having 3,000 Square Feet Heating Surface

The curved-tube, three-drum watertube boilers are in the majority of cases giving good service. These boilers, however, also suffer from lack of sufficient insulation of the steel casings.

Radical departures from these two standard watertube types have not so far proved satisfactory and in most cases are being replaced by boilers of the cross-drum, horizontal, straight-tube types.

The Engine-Room Force

Engineers for the vast number of new ships are necessarily made up largely of men who formerly did not have any marine experience. A great number of these men

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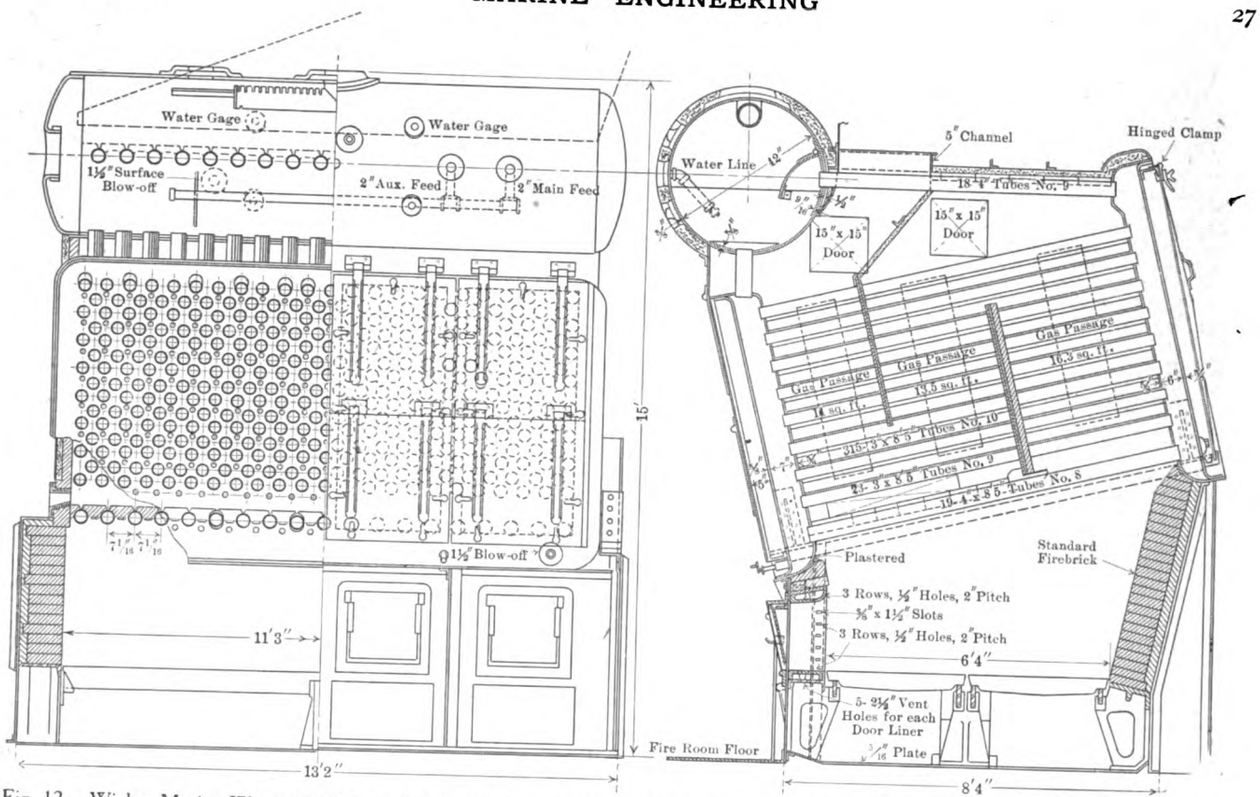

Fig. 12.—Wickes Marine Watertube Boiler. Heating Surface, 2,595 Square Feet; Grate Surface, 69.8 Square Feet; Working Pressure, 200 Pounds per Square Inch

were trained in land plants and are accustomed to operate watertube boilers and turbines under conditions which are more severe on the boiler than those ordinarily found in marine use. In land practice the water very often has large quantities of scale-forming material which deposits in the tubes and the steam demands fluctuate over a considerable range, whereas in marine use the boilers operate under a practically steady steam demand and with good feed water. Therefore, these engineers have had little or no difficulty with the watertube boiler at sea. They have, however, been used to feed water regulators in land plants for watertube boilers, and these regulators will also be used in marine service in the future.

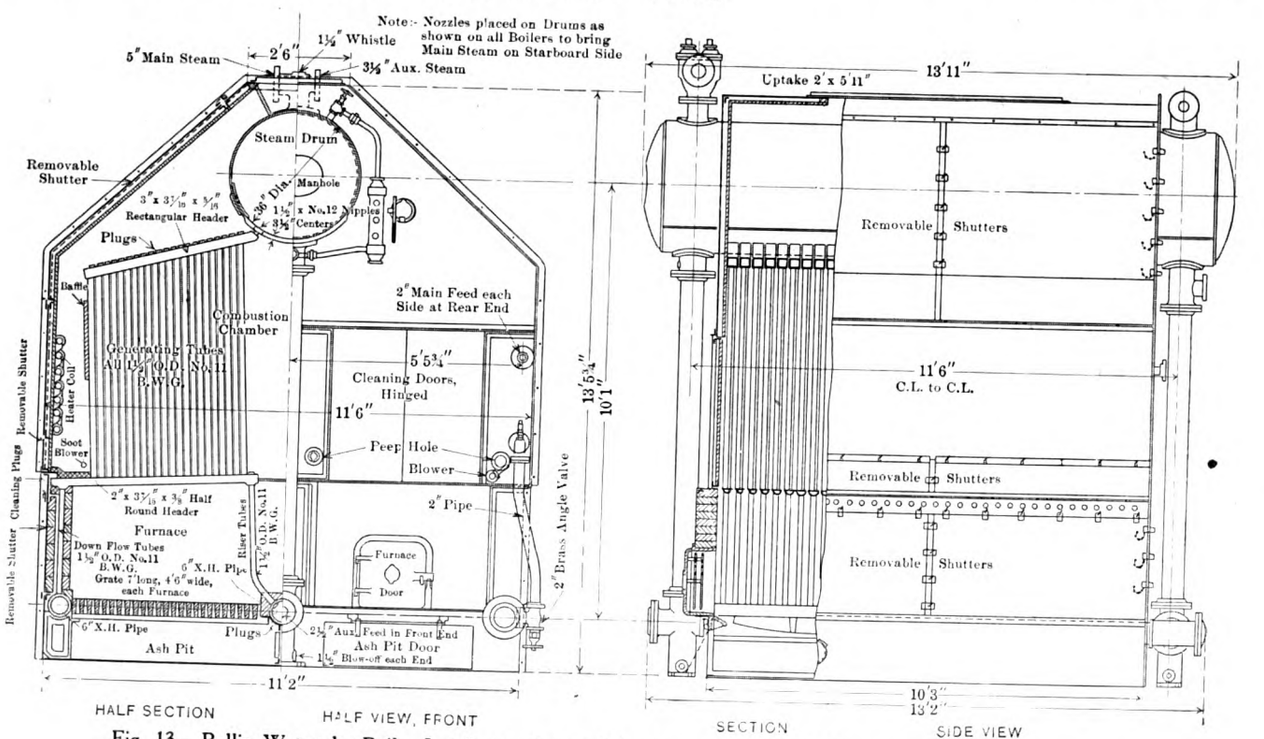

Fig. 13.—Ballin Watertube Boiler Installation Arranged for Use on Vessels of the Emergency Fleet Corporation

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There have been a great number of tests made of various types of watertube marine boilers. To date no comparative tests by trained experts and similar test equipment have been made of the Scotch marine boiler, therefore the comparison for economy and capacity of these two types under test conditions is not available. The shipowner, however, is interested in the comparative reliability, economy and capacity of the boilers when proper arrangement of baffles and larger furnaces for good combustion only possible with the watertube design. The capacity of the watertube boiler, as shown by the navy, is so vastly in excess of the Scotch boiler that no comparison is possible on this point. In recent naval tests a specially prepared express type of watertube boiler has been tested at a capacity of over 22 pounds evaporation per square foot heating surface. It is evi-

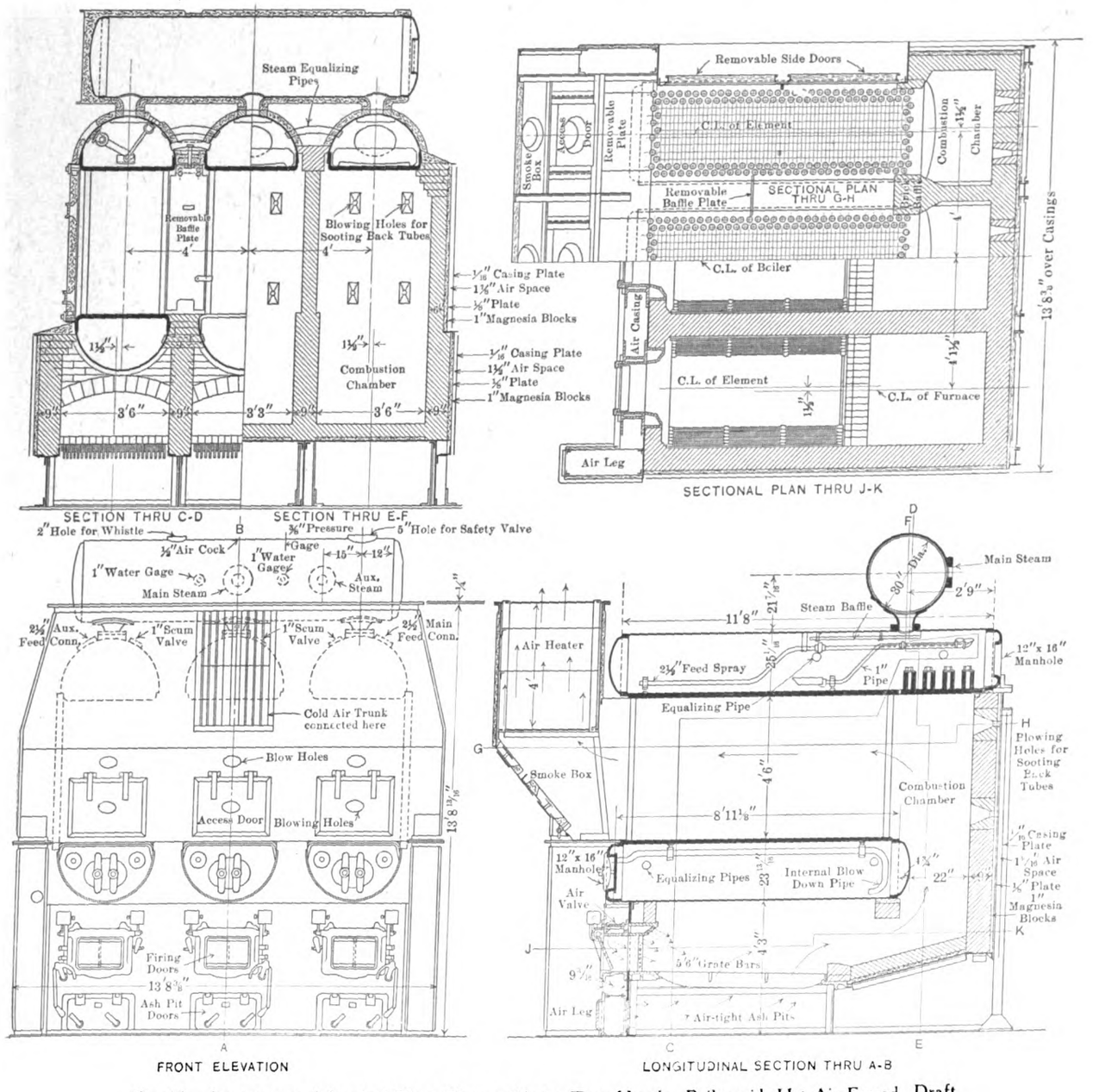

Fig. 14.—Arrangement of Standard Three-Element Marine Type Howden Boiler with Hot Air Forced Draft

operated under marine conditions at sea and not in test conditions for a short period under expert management.

Comparative Results

The experience of the various navies and isolated cases in the merchant marine have shown that under similar conditions at sea the watertube boiler is approximately 10 percent more economical in fuel on both short and long voyages. This is due to the longer gas passages, dent that the requirements of the merchant marine do not call for any capacity that would be detrimental to the reliability, length of life or economy of the watertube boiler. To insure a long life it is customary to operate watertube boilers in the merchant marine at an evaporation of approximately 5 pounds per square foot heating surface.

The repairs on watertube boilers are very much less than those on Scotch boilers and usually consist of fur-

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nace brickwork and grate repairs, when burning coal, or furnace brickwork when burning oil. In either case an occasional renewing of the lower row of tubes may be necessary if the boiler is not cleaned internally. All these repairs can be made by the ship's crew. In the case of Scotch boilers the repairs, such as calking, welding and scaling of the boilers internally, are not usually made by the crew, but by outside help.

The first cost of the Scotch boiler for 210 pounds working pressure, not including the necessary heated forced draft equipment and waste heat type superheater required for its economical operation, is, at present priecs, from $9 to $10 per square foot of heating surpace. The first cost of the cross-drum, straight-tube watertube type boiler for 225 pounds working pressure, complete with all fittings, is less than $6 per square foot heating surface. This relative difference in price is approximately the same as the relative difference in weight.

Scotch marine boilers weigh from 60 to 70 pounds per square foot heating surface, and merchant marine watertube boilers from 30 to 40 pounds per square foot heating surface. It is, therefore, evident that the advantages of first cost, weight, economy, capacity and length of life are decidedly in favor of the watertube boiler.

The Scotch marine boiler, however, is well known by the older type of marine men, and is preferred on account of its reliability when properly and carefully operated.

The records of the Emergency Fleet ships, complete to date, show that the watertube boiler is exceeding the Scotch boiler in reliability, and has a lower cost of both upkeep and operation.

During the next few years, when this record has been more definitely established, it is evident that the merchant marine will follow the navy and use the watertube type of boiler for the major portion of its ships. The Scotch marine boiler will be used, though at a decreasing rate, for a number of years owing to its past record for reliability.

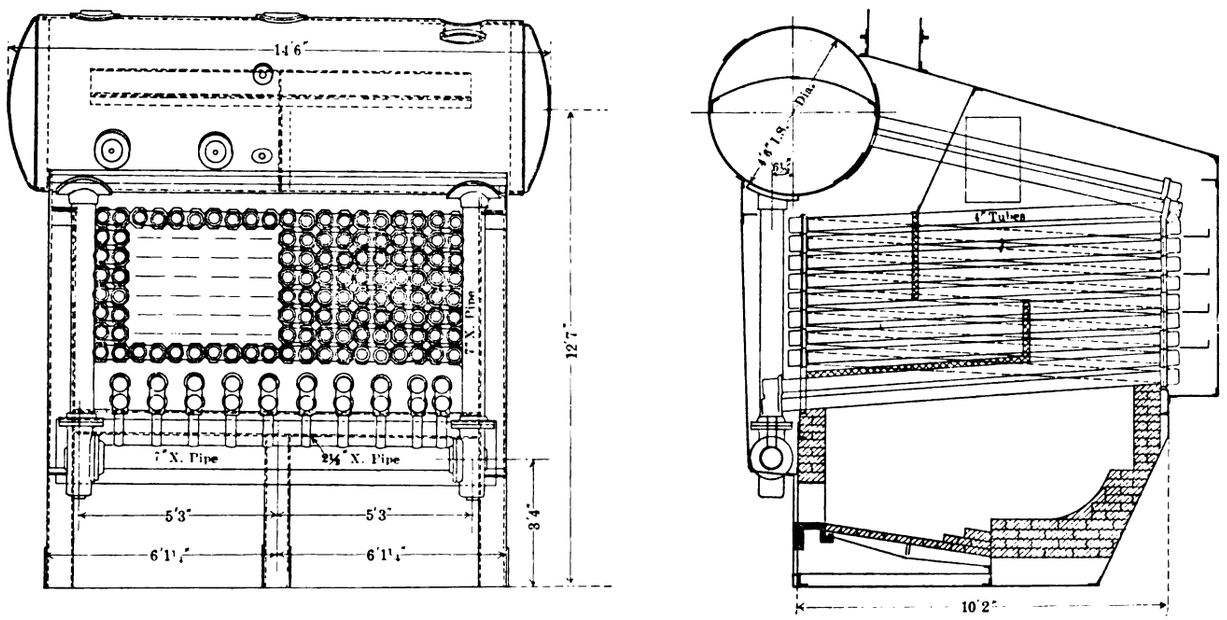

Fig. 15.—Craig Boiler. 2,000 Square Feet Heating Surface

New British Diesel Engine

Fifteen-Hundred Horsepower Diesel Motor Built by Swan Hunter and Wigham Richardson

AMONG the many leading British shipbuilding and engineering firms now producing Diesel engines is Messrs. Swan Hunter and Wigham Richardson, who are perhaps best known as the constructors of the *Mauretania*. Their new engine is of a distinctly novel type, and, although it is based essentially upon the Polar motor of the Atlas Diesel Engine Company of Stockholm, it embodies many entirely new features. It operates on the two-cycle single-acting principle, but instead of having separate scavenging pumps, either driven direct off the crankshaft at the end of the engine or by means of beam levers in front of the motors, there is one scavenging pump for each working cylinder, arranged directly below it and into which air at atmospheric pressure is drawn on the upstroke and compressed to about 3 pounds per square inch on the downstroke. The control of the air admission and its discharge into the scavenging trunk *C* is effected by means of the valve *A*, which is actuated from the camshaft by means of an eccentric and vertical link. From the scavenging trunks *C* and *D*, which act as reservoirs, the scavenging air enters the working cylinders through ports at the bottom when these are uncovered by the piston on its downward stroke, the top of the piston being shaped in a special manner to help in the effective admission of the scavenging air and discharge of the exhaust gases.

The piston valve *A*, in combination with the change valve *B*, serves another important purpose. In most Diesel engines starting is effected by admitting compressed air at 600 or 700 pounds per square inch into the working

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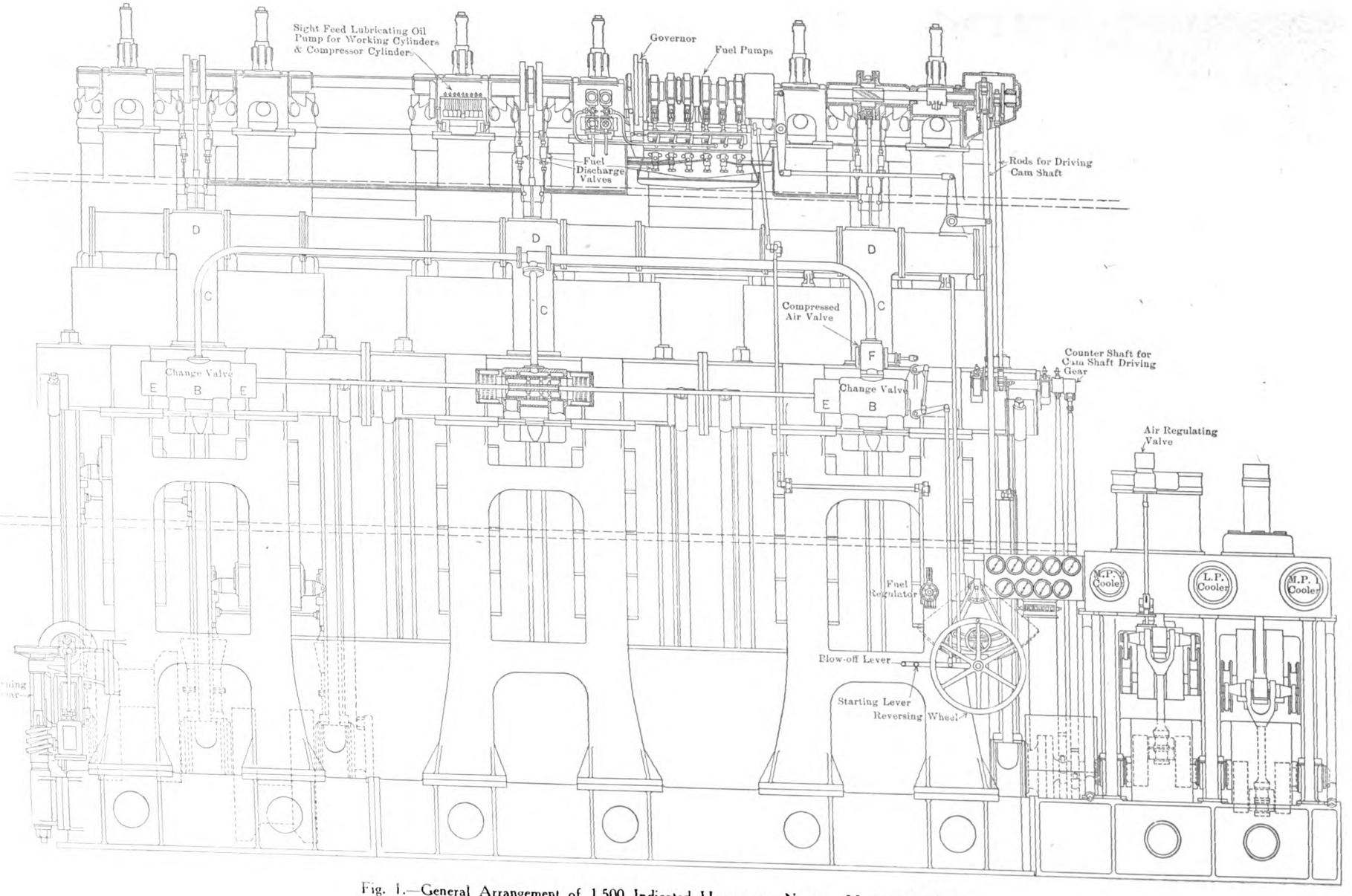

Fig. 1.—General Arrangement of 1,500 Indicated Horsepower Neptune Marine Oil Engine

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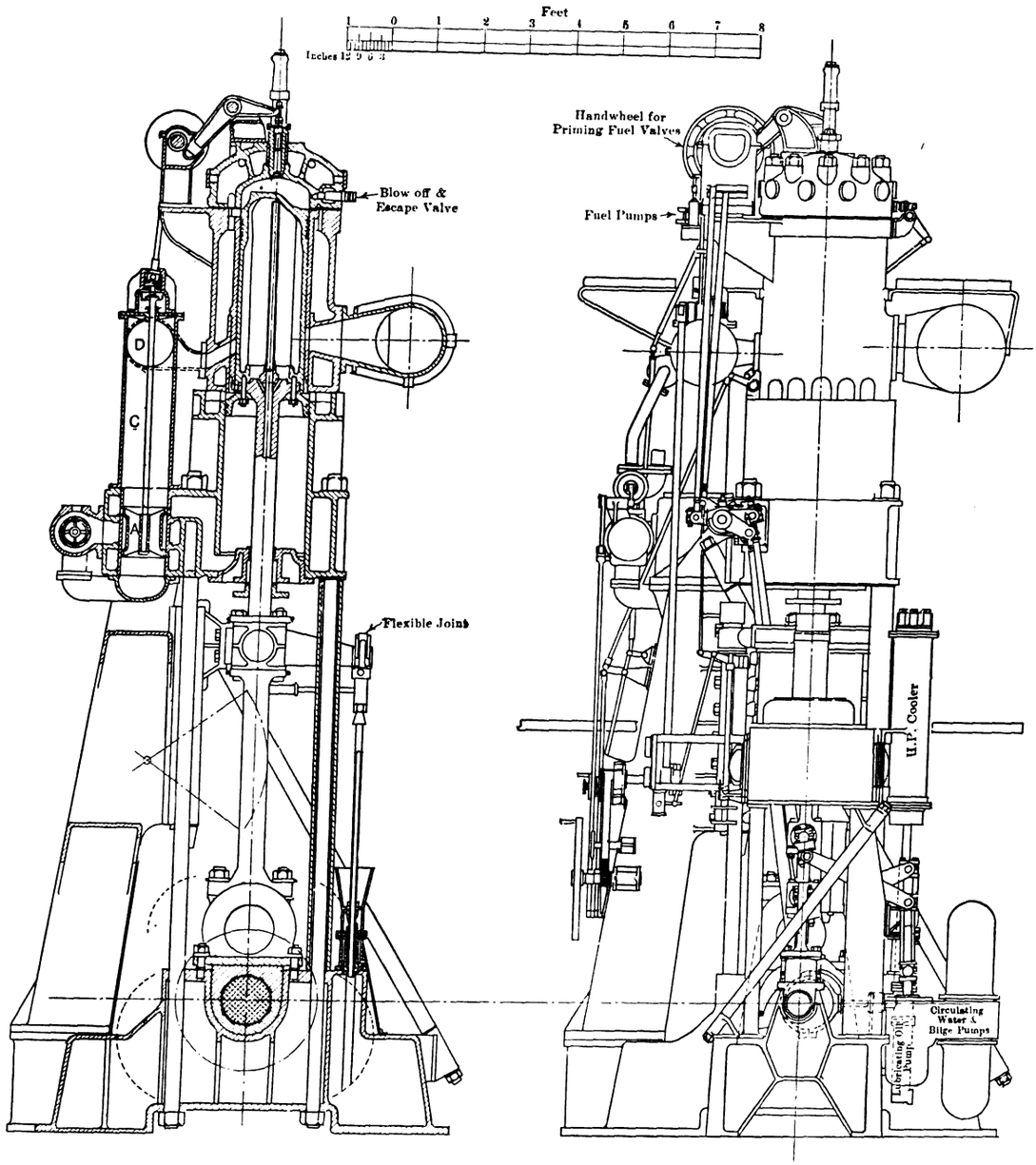

Fig. 2.—Cross-Section and End Elevation of 1,500-Horsepower Neptune Marine Oil Engine

cylinder above the piston, and although this method is generally satisfactory it has the disadvantage that, when the engines are being maneuvered, cold air is supplied to a hot cylinder.

In this new engine the scavenging cylinders are used for starting purposes and compressed air at only 100 to 150 pounds per square inch is admitted below the scavenging piston through the change valve *B* and the piston valve *A*. The object of the change valves can thus be seen. On starting up, these valves are rotated, thus closing the admission pipe to the atmosphere and opening it to the compressed air supply, so that now compressed air passes through the piston valve *A* into the scavenging cylinders instead of atmospheric air, which enters in the normal course of operation. These change valves are of the rotary type and are operated by means of a lever from the control station, so that on starting up compressed air is admitted until the engine fires, after which the valves are immediately changed over to allow air to be drawn into the scavenging cylinders from the atmosphere.

As the working cylinders are scavenged by means of ports, only one valve is required in each cylinder cover, which is for the admission of fuel. This is operated from cams on a camshaft driven from the crankshaft by long eccentric rods and a countershaft. When reversing an axial motion is given to the camshaft by means of the reversing wheel, thus bringing the rollers of the valve levers under the astern cam instead of the ahead cam. In order to provide easy starting and to allow of running at low speed, half compression cams are provided, both ahead and astern.

Some of the details of construction are unusual. The scavenging cylinders are supported on cast iron columns at the front and by vertical steel columns at the back, while the arrangement of diagonal columns to provide stiffness will be noted in the illustration. A pair of columns carries a pair of cylinders, and by this construction the engine can readily be standardized in four-, six-

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and eight-cylinder models. The cylinder liners are cast separately from the jacket or from the cylinder covers, so that in the event of a liner cracking it is only necessary to replace this part and not a complete cylinder, which would be necessary if the jacket and liner were cast in one, as is sometimes carried out in Diesel engine manufacture. The air compressor, which is driven from two cranks, forming an extension of the crankshaft, is of the four-stage single-acting type, with the usual inter-coolers, and with the exception of the high-pressure stage the cylinder liners are cast with the jackets. The circulating water and bilge pumps are of the plunger type, arranged at the back of the compressor, driven from levers, and sea water is supplied to the piston for cooling, passing right to the top of the piston through the pipe shown in the illustration and discharged at the bottom through the hollow piston rod.

The fuel is supplied to the fuel valves from six separate pumps, which are bunched together in the middle of the engine and are driven from the camshaft. The usual method of controlling the amount of fuel, and therefore the speed of the engine is adopted.

The engine, of which illustrations are given, is a six-cylinder model developing 1,500 indicated horsepower at 115 revolutions per minute, having a cylinder diameter of 18 inches and a stroke of about 3 feet.

Inland Waterways of France

Interesting sidelights on the French inland waterways have been furnished to us by Captain J. Murray Watts, U. S. A., who has just returned from France. Here he commanded Company E of the 57th Engineers, the inland waterways regiment which was scattered in detachments all along the rivers and at the ports of France. One section from Company E, under Lieutenant Hickey, U. S. A., was employed at Brest during the greater part of the war in the construction and repair of lighters. At this port, owing to the small number of docks, steam lighters and tugs were kept busy day and night in bringing men and ammunition ashore. Another detachment built and operated a shipyard at St. Nazaire, where twelve lighters were built from local material and a large number of tugs were rebuilt and repaired.

OWING to the congestion of the French railways during the war, a large amount of bulk freight was carried by river steamers, power barges, steam tugs and lighters to certain stations which served as central distributing points. The canal system is so extensively developed in France that it is possible to take a barge from Bordeaux on the Atlantic coast through to Cette on the Mediterranean by canalized rivers and canals. The extent of the French canals may be realized from the following incident. On one occasion Captain Watts was ordered to inspect some small river tugs at Montauban, a town situated about half way between Bordeaux and Cette. He subsequently took one of these boats, upon which repairs could be made, down the Garonne river to Bordeaux, thence by the Bay of Biscay up the Loire river to Camp Gron at Montoir, where a shoal draft tug was needed in building a new dock. This structure, by the way, was nearly a mile long and extended out into the deep water of the Loire river in the form of the letter L.

A large number of these French canals were planned by Napoleon. In fact, many of them run parallel to the great system of military roads or Routes Nationales. Often these roads are built in three strips along the banks of the canals—one section of grass for the cavalry, the middle section of macadam for the infantry and light automobiles, and the third section of granite blocks for the artillery and heavy trucks. By this arrangement freight can be loaded onto the trucks from barges at points convenient for distribution. Instead of having the railroads and inland waterway systems antagonistic, as is often the case in America, the French canals carry the bulky freight, leaving the higher-priced fast freight for the railways, to their mutual advantage.

Traffic on the Seine river from Havre to Paris and from Paris through the canalized portion of the Marne to Chateau-Thierry and Dormans is thoroughly practical. On the Loire, from St. Nazaire to Nantes, good-sized steamers can be employed to advantage. Above Nantes, as far as Tours, the traffic is handled by barges.

The type of river barge favored in France and Belgium is a steel boat about 164 feet long with a heavy duty oil engine in the stern, and an additional small oil engine for handling the winches. Owing to the destruction of the coal mines in northern France by the Germans, the cost of coal is very high. Consequently the use of crude oil engines is particularly advantageous, since crude oil can be obtained from Holland at a price which proves satisfactory when the relative economies of the oil and the steam plants are compared.

The accompanying photographs show some of the smaller steam tugs and inspection boats used in the inland waterway service. A number of barges and tugs using gasoline (petrol) for fuel are employed.

Some of the more up-to-date barges have electrical plants and operate their winches by electrical motors. Rather large propellers and medium speed motors are used because the French rivers, while not appearing very large on the map, are quite deep and the current generally runs from 1¾ to 3 miles per hour. After the armistice was signed considerable traffic was handled on the Rhine between Antwerp and Coblenz by motor barges.

The locks and gates of the more modern canals are equipped with up-to-date machinery. However, the greater number of locks and gates are operated by the old-fashioned hand control. During the war these were operated by young girls and the older peasant men. It was found advisable to obtain permits for the American engineering crews stationed on river boats to be allowed to operate these locks. This arrangement resulted in a great saving of time.

Working in conference with the French engineers after the armistice, Captain Watts, as liaison officer, became familiar with future plans for the development of French waterways. The Department des Ponts et Chausses, which is in charge of the Government bridges, docks and canals throughout France, plans to increase greatly the capacity and number of canals to accommodate after-the-war traffic.

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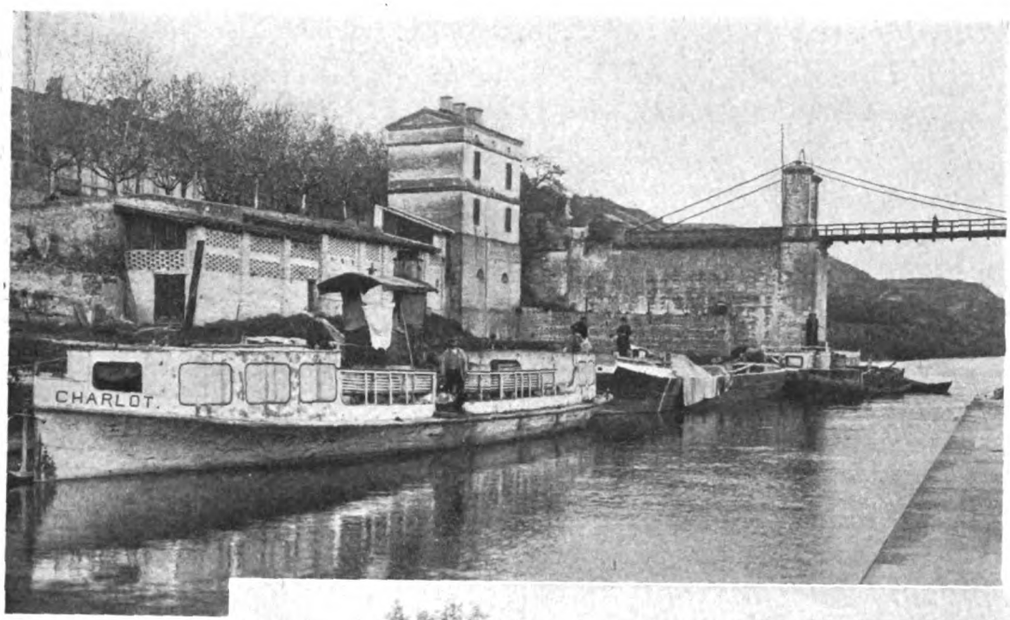
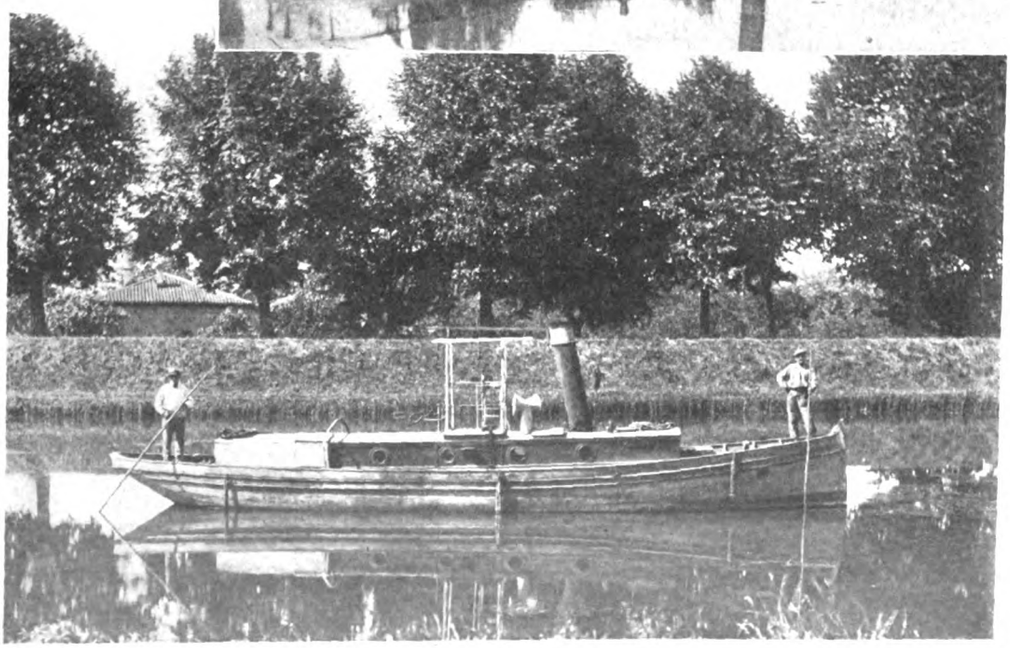


Charlot, the Small Steam Work-Boat Used in the Canal "du Midi" at Montauban

The Tug *Yvette*, Which Was Used by the American Government at Bordeaux



Suzanne, the Shallow Draft Tug Which Captain Watts Brought Down from Montauban on the Garonne to the Engineers at Camp Gron on the Loire

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United States Battleship Mississippi

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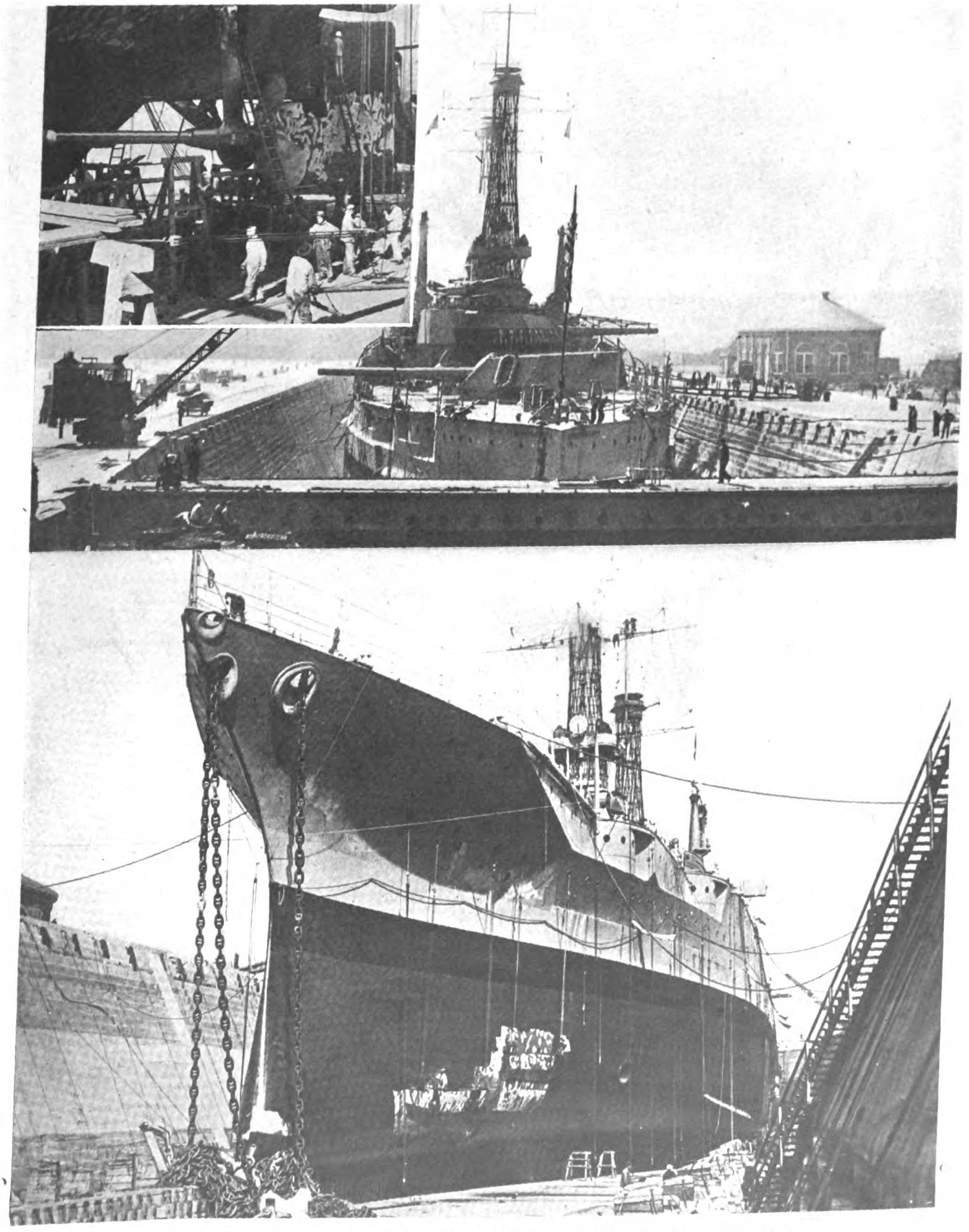

Views of the Super-Dreadnought *Mississippi* in the Hunter's Point Dry Dock at San Francisco

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"Economy Rampant"

The Amazing Career of a New Steamship Manager—His Struggle with the Coal Barons and the Final Reckoning

BY A WELL-KNOWN STEAMSHIP OPERATOR

THE first set of books that I acquired by purchase consisted of a very beautiful special edition (printed exclusively for early subscribers) of the *Encyclopedia Britannica*. Sample copies of its pages and of its elegant binding (accompanied by terms of subscription and the inevitable contract) were submitted to me by one of the typical old-time book agents, who assured me, as he took the "five-dollars-down" first payment, that I might consider myself to be thereafter among the comparatively favored few who could boast of possessing and having at his fingers' ends all that was worth while knowing in this world. This happened many years before the advent of Dr. Eliot's five-foot shelf.

I was eager to acquire knowledge, and I set myself to the pleasant, though arduous, task of giving an hour daily to my new-found friend, the encyclopædia. For ready convenience I had built for my books a set of shelves that fitted in a niche of my room. Years later, when a lighter edition appeared, I made a present of my early literary venture to a friend, and the books, which had reposed serenely on their shelves, untouched and unsullied, had to be removed practically by using cold chisels and mallets, so compactly and homogeneously had the beautiful leather volumes stuck to each other in close and undisturbed companionship.

It was thus that I became educated, and it is for this reason that I have always had a soft spot in my heart for book agents. Book agents, like life insurance brokers, are, I think, blessings in disguise and worthy of greater consideration than we usually accord to them; because, were it not for their importunities, we would be uneducated, unread and unpolished, and likewise unprotected against the uncertainties of life. Book and life insurance agents filled my office and my home and drew from my income for years, forcing me to lay up for assessments and premiums what I might otherwise have spent for sailing yachts, cigarettes, automobiles and other luxuries.

It was my faith in these perambulating dispensers of education and protection to my estate against premature death that made me an easy prey to the wiles of their cousins in the trade: the old-type canvassers, or drummers, of just American fame.

My First Experience in Steamship Management

I had graduated from the accounting department of the organization in which I served and had been given an opportunity to show what talents I possessed to manage the operating branch of our industry, when my experiences began. My first visitor was a dapper young fellow who represented a manufacturer of anti-corrosive and anti-fouling compositions. He was a chap of unusually fine appearance, and he used the very choicest of words, which flowed through his lips like an unimpeded torrent of water in a spring flood.

"Far be it from me," he began, "to run down the excellent product that some competitor may be furnishing to you. But whatever composition you use—whatever you pay for it—I am certain that I can more than satisfy your needs if you will give our compositions a fair trial."

"But," I asked, "if the article which we are now using is giving satisfaction and the price is right, why should I change?"

"Because," he quickly retorted, "our compositions are made after a secret formula, the result of many years of research. They are absolutely inpervious to marine growths. The smoothness of the ships' bottoms when covered with our products will be such that I guarantee you a saving of at least 15 percent in your coal bill."

"But what has coal consumed in our ships to do with the paint that is applied to their exterior?"

"The resistance," he answered, "of a ship's mass as it is propelled through the water is greatly lessened by the use of our preparations because neither marine grass, nor barnacles, nor the hitherto inevitable slime that adhere to ships' plates under water can possibly grow or develop. Other compounds in the market do not give this protection, hence you are pushing an unnecessary quantity of foreign and injurious matter through the water. By eliminating these parisitical formations you save power; by saving power you save steam; and by saving steam you save fuel; and the exhaustive tests that we have made show that this saving varies between 10 and 15 percent."

The convincing voice and earnestness of manner made me capitulate.

Coal Requisition Reduced 15 Percent

That day I made an entry in my record book and issued orders to our marine superintendent to reduce our requisitions for coal to the extent of 15 percent. As our coal requirements were two hundred thousand tons annually and the price $3.50 (14/7) per ton, I noted in my little book a saving to my company of $105,000 (£21,600) per year, and, figuratively speaking, patted myself on the back and sallied forth well satisfied with a good day's work.

My next visitor from the fraternity of canvassers was a brawn, heavy, middle-aged man, who spoke with a decided Scotch brogue.

Sherlock Holmes would have at once proclaimed him a Scot—and so he proved to be—and, of course, being a Scot (a "canny" one at that), I guessed him to be a retired ship engneer, and my guess turned out to be an accurate one.

He offered me a cigar, which, like all the cigars in all the tales that I have ever read, was long and black. I declined to take it, whereupon he laughingly remarked that he did not wonder at my refusal to accept his tender, as no doubt with the oportunities at my command—operating ships to the land of nicotine—I could readily and abundantly supply my needs and those of my weed-loving friends without having to pay to Uncle Sam the iniquitous tribute that the United States customs laws exacted.

I begun at once to distrust my visitor, but as he unfolded certain blueprints and statistical tables before me to illustrate the wonderful apparatus that, under royal patents, he was installing in many vessels' boilers to improve and normalize their circulation, I became interested, and I entered into the proposition that lay before be, forgetting at once all about his objectionable personality and insinuatingly insulting remarks.

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The device which he sought to sell or rent to us would, he claimed, prevent a fault common with marine boilers that were not provided with his device. Instead of carrying water at varying degrees of temperature, due to stagnation and other causes, it would, induced by his patent machine, remain constant; steam would generate more readily and evenly; power would increase and the saving in fuel as a result of these changed conditions would, he assured me, reach anywhere from 10 to 15 percent, as proved by tests made in a large number of ocean-going vessels; so many ships, in fact, that upon my asking him for the name of one single vessel that might serve me as a convincing guide, he could not mention it—so many names, no doubt, having confused him.

Another 15 Percent Fuel Saving Promised

I insisted, however on being told the name of at least one ship that carried a circulator, and was informed by my visitor (not without some reluctance) that the high-pressure tug *Puffing Billy*, built in 1837, engaged in towing barges from Gowanus Creek to Barren Island, was being successfully operated with one of the wonderful circulators, and that her captain-owner, Mike O'Flarety, would be glad to testify to the worth of the apparatus.

Now, with 15 percent of coal already saved by using my friend's compositions, why not add to the lustre of my business career, so auspiciously opening before me, by showing my president and board of directors that I could save another 15 percent at a paltry additional cost of a few hundred dollars to install the ingenious Scotch circulators in the boilers of our ships?

I signed the contract and jotted down in my book an entry showing a sum of $89,250 (£18,320) to the good, with visions of a large increase in my salary and a high-sounding title to go with it.

A few days later I was discussing the value of my discoveries in economy with our marine superintendent, and, wondering why he did not enthuse, when I received a call from a smooth-looking and smooth-talking individual, who presented a letter of introduction from a friend of mine, stating that the bearer was honest, trustworthy, upright, painstaking, earnest, gentle and kind, and that he had something to submit to me which he (the writer) believed worth while considering, etc.

New Lubricants Are Offered to Reduce Our Coal Bills Still Further

I had long suspected that the lubricants we were using were full of grit and sand and other substances calculated to impair and destroy the efficiency of our engines because our repair bills were unusually high and our ships' engineers attributed the poor speed obtained in part to the inferior quality of coal furnished, but chiefly to the inferiority of engine oils supplied.

Here was a man who manufactured, refined and sold lubricating oils—and the letter said he was honest. What better could I do for my company, whose interests I had at heart, than to put myself in his hands? I questioned him as to the viscosity and density and many other properties that oils are supposed to possess, but of which I knew nothing, merely to impress him with my apparent knowledge of such matters.

He replied very candidly that his company's products were the best, and because the best, the cheapest, adding that no matter what we were paying for oils he would sell his product 5 percent cheaper just to introduce us to a good thing and to make us his friends forever. "For," he added, "once you begin to use our article you will perceive a decided improvement in the speed of your ships, due to the lesser friction in their engines.

"This, he said, "will also be reflected at once in your coal bills, and at least 15 percent will be saved; so that if hitherto you have burned in a trip, say, a thousand tons of coal, you will hereafter make the same trip under the same conditions with a consumption of 850 tons."

Our Expected Fuel Savings Total Nearly 40 Percent

I asked him where and how he carried on the experiments that made him so cocksure of the value of his lubricants, and he admitted that none had taken place on *ships*, but such experiments had taken place on *land plants* on the Jersey meadows, so close, however, to salt water that for all practical purposes the tests could well be considered to have taken place at sea.

I gave him the order in perpetuity and made a note in my book of another 21,675 tons saved, and called the traffic manager in consultation.

"The saving in coal," I said to him, "gives us additional space for cargo."

The decrease in dollars for coal not consumed and the added increase in earnings from additional cargo carried and freight earned looked very good to me.

Surely, I said, the directors will pay me a substantial bonus when I prove to them that I have to date saved fully 38.287 percent in coal, to say nothing of giving the ships space for additional accommodations and increasing their freight-earning power.

The Fresh Water Problem Is Attacked

The enormous quantity of fresh water used by ships in the regular course of their travels, and the exorbitant price that at foreign ports had to be paid—or at least was charged in the accounts that our agents periodically sent with accompanying vouchers and with stamps of approval affixed thereto—led me to make an inquiry into the matter, and in some mysterious manner (which in my innocence I have failed as yet to discover) the mere idea of making such an inquiry had hardly taken form in my mind when I received a call from the agent of a concern that manufactured, installed and guaranteed the working of evaporators, that is, machines with which quantities of the common and ever-abundant salt water of the seven seas could be converted into fresh water free from the injurious effects that salt has upon ordinary boilers.

That from twenty to forty tons of briny liquid could in twenty-four hours be converted into the softer liquid had not entered my soft-brained head, and the evaporator man found in me ready ears and a very receptive mind when he proposed to install evaporators in all of our ships, thereby effecting not only the saving which would accrue by reason of the lesser quantities of water that we would have to purchase and carry, but, as my friend pointed out, would indirectly save the coal pile, because, as he ingeniously explained, the fuel required to generate the heat to evaporate the requisite quantity of water would amount, as he had proven by actual tests, to 10 percent of the fuel required to project a more heavily laden ship carrying the same quantity of water in her tanks, and this, he added, amounts in a forty-ton evaporator to approximately 15 percent of the total coal ordinarily consumed in a boat of average displacement and speed.

Forty-Ton Evaporators Are Ordered

I at once closed a contract for a large number of forty-ton evaporators, and jotted down in my book another item of saving, perfectly assured of the prospects of my being counted chief among all American steamship operators.

Many people question the power of mind-reading. I never believed in it until a day or two after the closing of the evaporator contract the sales manager of an en-

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gineering company that made a feature of feed water heaters walked into my office and told me confidentially that he had called for the sole purpose of saving my company big money. (It reminded me of the fakir at Coney Island selling rings at five for a dime, the purchaser having the privilege of tossing the rings with the object of putting through them canes placed perpendicularly a short distance away, all the while proclaiming in a loud voice: "Gentlemen, remember that we are not here to make money; we are here solely to give away canes!")

FEED WATER HEATERS ARE NEXT INTRODUCED

The sales-manager unfolded a scheme that actually made me open my mouth in wonder. Here was an apparatus that heated water before it entered the boilers, thereby generating within them an even, normal, regular, constant, continuous, permanent, efficient, live steam. He used all these words to impress me! Instead of steam blowing hot and then blowing cold, as is the case under the ordinary method of pumping and filling, you have, of course, a constant supply of hot water pouring into the boilers as fast as the water therein evaporates, quickly replenishing the live steam as it finds its way to the engines.

"Careful calculations, checked and verified by numerous rigorous tests, show," he said, "that in passenger ships of high speed a saving in fuel of not less than 15 percent is effected where our feed water heaters are used."

"Therefore," he added, "I cannot too strongly recommend their adoption by a company that is so ably managed as yours."

I asked him if he had ever been to sea and personally tested the heaters under the varying conditions of a long voyage. By dint of patient and tactful cross-examination I finally got him to admit that he had never steamed beyond the fishing banks on the good old side-wheeler *Angler*.

And, as the man told me that all he sought was to save us money, I felt so grateful to him that I showed my appreciation by placing an order forthwith for the requisite number of feed water heaters, with the understanding that if they proved satisfactory we would cheerfully give him an elaborately worded testimonial of their worth.

SUPERHEATERS ARE INSTALLED

Have you ever heard of superheaters? Superheaters are cleverly devised drums placed on the tops of boilers to store steam and keep it dry before it enters the main steam pipes on the way to engine cylinders or turbines. Marine boilers frequently prime; that is to say, they bubble over, creating a foam that chokes the pipes and engines. Superheaters were designed to obviate this difficulty, but I was ignorant of this because our engineers had not enlightened me on the subject; therefore, when a kind-hearted agent appeared one day with a proposition to install superheaters on all the boilers of our ships I became interested.

Well, nothing would do but we must adopt the superheaters and be in the fashion. All the live steamship companies had installed superheaters. Had we? If not —why not? We must eventually. If eventually, why not now? To use fuel for the mere sake of seeing it turn water into bubbles, instead of good, dry, powerful, live steam was foolish. A saving of at least 15 percent in the quantity of coal would be effected by installing these very necessary appurtenances to our generating units. The agent said so, and the order went forth at once to have the installation made. Let it be! And it was!

Another cut in the economy stick! Another saving of at least fifty thousand tons in fuel! Another substantial volume of space allotted to cargo, with all the collateral benefits that would accrue from decreased displacement, enlarged capacity and improved speed.

Engineers tell us that the loss in power caused by unavoidable friction of engine parts equals not less than 80 percent, and that speed is reduced proportionately. The importance, therefore, of having certain portions of a complicated system of machinery parts that revolve around or within other parts protected by soft metals that will hold securely without undue binding is, apart from the saving in the wearing of parts, a very essential factor in a well-designed engine.

My interest was thoroughly aroused, therefore, when I learned of the anti-fake and anti-friction yellow metal composition, produced under a secret process, and a request for information brought a representative of the manufacturers, who, after many explanations, showed me that a saving in fuel of from 10 percent to 25 percent (according to the type, speed and character of the propelling machinery) could be obtained.

Making allowances for the extravagant claims that I imagined the agent was making, I conservatively figured that 15 percent in saving would not fail to result if we remetaled all the bearings of all the engines in all the ships in the service; and in due course the necessary orders were issued and the repair yard—ever eager to do a good turn—reaped a harvest in tearing out and fitting in the new bearings.

By gradual steps, or by what I might term a process of amortization in the application of economy, I had now arrived at a fair estimate of our accumulated savings in fuel of no less than 95 percent of the normal consumption. But it was not enough!

FUEL SAVINGS OF 95 PERCENT NOT ENOUGH!

When soon thereafter my attention was called to certain patented devices called retarders, conceived and placed in the market for the purpose of regulating and curtailing the excessive inductive air drafts to which ordinary ships' furnaces were subjected, I sent for the manager of the makers, and in a short time became convinced that the installation of such retarders would lead to a very considerable saving in the operating expense of our propelling units.

One of the main advantages that (since its adoption) oil fuel has shown to possess over coal fuel is that the heat produced by the former is constant, while with coal furnaces, which require frequent cleaning, replenishing, regulating, etc., the generation of steam is arrested and the even speed of vessels affected.

To avoid as much as possible the sudden drops in heat energy, firemen usually take turns at their respective stations and open furnaces assigned to each and feed them in rotation. Yet the loss in energy is very considerable, and the result is that no ship speeds along (sea currents and winds remaining constant) at an even rate. It follows, therefore, that the speeds recorded for vessels at sea are always average speeds.

The importance of providing a suitable check to this condition was apparent, and I promptly took measures to install the new apparatus, feeling assured that the saving of gases (which, unburnt, were drawn through the ship's stacks without profit) would more than compensate for the expense of installing the retarders.

This saving, I calculated (based on figures furnished by the makers) to be 15 percent of the fuel which under ordinary conditions would be consumed, and my book recorded another decrease in consumption, which in

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terms of finance I conservatively put down at $15,000 (£3,080).

Numerous other devices to further reduce consumption of fuel were contracted for by me during the following months. The ships were apparently making good time and performing their respective services without hindrance. All the coal consumed by the entire fleet amounted—according to my records—to the quantity that would ordinarily be consumed in the Baltimore heater of an East Side boarding house parlor.

I had achieved the impossible!

I had sounded the death knell of the coal barons.

I had released for the use of other industries enormous quantities of fuel!

I was a public benefactor—the peer of steamship operators—a veritable wizard!

In the course of time the ships' accounts were prepared and submitted by the auditors, and I discovered—first with distrust and doubt, then with amazement and horror—that they contained charges for coal purchased at outports at prices ranging from 100 percent to 200 percent in excess of the contract prices at home.

The investigation that followed showed that our marine superintendent, having come to the conclusion that I was suffering from "dementia economica," had (to save our business from perdition) secretly ordered the replenishment of the ships' bunkers at foreign ports where coal was scarce and excessively dear——

AND THEN I AWOKE!

Marine Oil Engine Construction and Motorship Building in Europe

BY OUR SPECIAL LONDON CORRESPONDENT

WITH the improving supplies of raw material in Europe there are signs of increasing production of motor ships, and the largest vessels of this type so far built, the *Glenariffe* and *Stureholm*, have recently been completed at Glasgow and Gothenburg, respectively, while the *Buenos Aires* was launched at the last-named port a short time ago. It is hoped that within the next month two of the largest motorships ever constructed will be put into the water, one at Glasgow and the second at Copenhagen, both the vessels having a deadweight carrying capacity of 13,000 tons.

The *Glenariffe* is a 10,000-ton ship owned by the Glen Line and is a product of Messrs. Harland and Wolff, who are now occupied to the fullest possible extent in turning out large motor ships at Glasgow. The new vessel is 406 feet in length and is equipped with two four-cycle engines of the six-cylinder type, developing 1,800 indicated horsepower at 115 revolutions per minute and having cylinders 26⅜ inches diameter and 39⅜ inches stroke. The *Stureholm* is owned by the Swedish-American-Mexican Line and carries 9,200 tons at a speed of 11 knots, being fitted with two 1,300 indicated horsepower engines built under license from Burmeister and Wain in Sweden. The *Buenos Aires* is of approximately the same size, but is equipped with rather larger motors, each developing 1,550 indicated horsepower. She is owned by the North Star Line of Stockholm, which firm already has a very large fleet of motorships and has four more under construction of the same type.

Use of Steam Eliminated

An interesting feature of these new vessels, and, indeed, of most of the motorships which have recently been constructed, is that steam is practically entirely dispensed with and all the auxiliaries are electrically operated, in some cases even the heating of the ship being effected by means of electric radiators. It is true that electrically driven auxiliaries, such as winches, steering gear, etc., are rather more costly to build, but they are less expensive in upkeep and generally so much more convenient than steam plants that owners having had experience with both types are now invariably adopting the electrical system.

So urgent has the demand for new motorships become in Scandinavia that owners are finding it quite impossible to get new vessels built owing to the existing yards being fully occupied with orders in hand. Many Norwegian shipowners are therefore attempting to obtain such ships in Great Britain, but even there facilities are limited, and the number of engineering firms with sufficient experience in the manufacture of marine oil engines is limited. In order to cope with the demand and to avoid the long period of experimental work necessary if an oil engine is to be developed from the very beginning, licenses are being taken up by prominent British shipbuilders for the manufacture of well-known Continental engines. In this way it is hoped to increase the output of motorships rapidly in British yards, and before the end of next year it is anticipated that the motor shipbuilding industry will have developed to an enormous extent.

In the meantime, with this shortage of available oil engines and the difficulty of producing them quickly, the British Admiralty is disposing of a large number of submarine engines, which are no longer required. Many of these motors are of 800 horsepower of the well-known Vickers type, and the surplus supply of these sets may be realized when it is stated that at the time of the armistice there were no fewer than twenty leading engineering concerns in Great Britain building submarine Diesel engines of the Vickers type. All the engines under construction were completed, and as very few of them have been required for new submarines they are being disposed of privately whenever the occasion offers.

Adaptability of Submarine Type Diesels

It will be of interest to American shipowners, who, no doubt, have heard various reports regarding the reliability or otherwise of large auxiliaries, to learn that many of these submarine engines are being installed in existing sailing ships. Several such vessels belonging to the Anglo-Saxon Petroleum Company have been converted into motor tankers, and many of these conversions were actually carried out in China, Australia and other parts of the world in vessels trading in those districts.

Two 5,000-ton ships were recently equipped with a couple of 800-horsepower Vickers engine in Hong Kong, the motors being dispatched from Great Britain. Several others in Australia have been fitted with hot-bulb engines

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of the 320-horsepower Bolinder type, originally intended for naval craft. This method of disposal of oil engines built for war purposes certainly has its advantages, especially at the present time, when long delays are occasioned in manufacture, owing to labor troubles and shortage of materials.

New Type of Oil Engines

A new type of oil engine is now being manufactured by several firms in Great Britain which may lead to important developments in marine oil engine construction. At present the well-known firms of Crossleys, Ruston and Campbells are building the new engine for stationary purposes, but the first-named concern will shortly manufacture it for marine work as well. It is a four-cycle machine and aims at obtaining the same results as the Diesel engine without the complication of the latter. Its only difference in principle from the ordinary stationary four-cycle oil engine is that the compression pressure is a good deal higher, being between 300 and 400 pounds per square inch, while the combustion chamber is of special design and is almost spherical in shape. Fuel is injected into the combustion chamber mechanically through an atomizer of less delicate construction than that of a Diesel engine.

With this motor the fuel consumption is not more than 10 percent higher than with the best Diesel engine (averaging about 0.42 pound per brake horsepower hour), but, owing to its simplicity and the lower pressure, the cost of construction is relatively small, being somewhere in the neighborhood of $60 per brake horsepower, as against $100 per brake horsepower for most Diesel marine engines at the present time. It is, of course, started by compressed air in the ordinary way, but no heating is required as with the semi-Diesel engine. It may seem strange that results can be achieved which it was formerly thought were only possible with Diesel motors, and it would appear that one of the main reasons for the advantages gained is that the combustion chamber is of the exact shape to allow very efficient combustion and atomization. At any rate, the engines are now being built, and long tests have proved that all the claims made are well founded.

Other Oil Engine Developments

Other interesting oil engines are now being developed and the activity which is being shown in this direction indicates that the marine oil motor has by no means reached its limit of perfection. One of these new engines will be a 1,000-horsepower semi-Diesel type, and as the highest powered set of this class that has ever been constructed previously is of 500 horsepower it is clear that the new engine will mark an important step forward in the design of hot-bulb motors. The first unit is now under construction, and if the trials prove it to be thoroughly satisfactory in every respect for marine work it will be standardized and built on a large scale in competition with Diesel engines.

Another interesting development is the new Diesel engine which is being brought out by the Tuxham Company, one of the best-known manufacturers of hot-bulb oil engines in Scandinavia. The new engine is of the two-cycle type and differs from every other Diesel motor in that the system of crank-chamber compression is employed. The object of this design is to eliminate the large scavenging pumps usually necessary and thus reduce the cost of construction. The disadvantage is that the fuel consumption is somewhat higher, while the enclosed crank chamber renders the examination of the connecting rod and connecting rod bearings a somewhat troublesome proceeding. The first motor of the type will shortly be put upon the market, and it will be built in sizes from 250 brake horsepower upwards.

Congress Seeks a Merchant Marine Policy

Senate Committee on Commerce About to Take up Legislative Measures Relating to the Government-Owned Merchant Fleet

BY WALDON FAWCETT

WITH the advent of 1920, the upper house of Congress, after numerous delays and digressions, seems at last disposed to grapple with the question of determining upon the public policy with respect to the expanding American merchant marine, nurtured of war-time conditions. This means, of course, that Congress as a whole is in a fair way to accomplish conclusive results in this quarter. The House of Representatives, it must be conceded, had shown, prior to the adjournment of the extra or special session in November, a readiness to proceed with a definite merchant marine programme having duly approved the Greene bill, which constitutes a long step toward the permanent disposition of the war-begotten fleet, but so long as the Senate refrained from sympathetic action the initiative in the House counted for little.

Now that the Senate committee on commerce has announced that it will in mid-January enter upon consideration of a whole group of proposed legislative measures it is reasonable to suppose that determination of a Federal policy is in sight, even though a certain amount of time be required for compromise in the event that the Senate prefers its own plan for the disposition of the Government-owned fleet to that to which the lower House has given formal approval. That shipping and shipbuilding interests are alert to the formulation of a plan of action that will conserve the resources that the war has inspired and encourage their expansion is shown by the large number of spokesmen for the industry who have indicated that they wish to be heard.

The Senate committee will open on January 12 its general hearings on the fundamental questions of merchant marine policy, but four days earlier there will be inaugurated what promises to be a spirited discussion of a plan whereby the United States Shipping Board would be authorized to adjust the claims of wooden-ship builders arising out of the prosecution of the war. This is, in effect, an effort to have the national government fulfill in reasonable degree the oral promises made to wooden-ship builders in the days when a prolonged war was in prospect and when Government officials, in eagerness for the speedy provision of maximum shipbuilding capacity, encouraged builders to provide plants and equipment, but did not, ere the signing of the armistice, confirm their verbal assurances with regularly executed contracts.

The remedy for a situation that is clearly calculated to work hardship and injustice upon many wooden-ship

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builders was projected by Senator Jones of Washington, and the bill is designated officially as S. 3451. The bill authorizes the Shipping Board to adjust, liquidate and pay the claims of individuals, firms or corporations who built or contracted to build wooden ships for the United States after April 6, 1917, and which cannot be paid under the law as it now is. It is provided that no claim shall be liquidated or paid unless it is found to be based upon a request or demand of the Shipping Board, the Emergency Fleet Corporation or a representative of them. Claims must be filed with the Board within three months of the approval of the act. In order to be made a basis for claims, moneys must have been invested or obligations incurred (incident to the production of ships) prior to November 12, 1918, and it must appear that obligations were incurred in good faith upon assurances of a representative of the Government that reimbursement would be provided in money or contracts for additional work. No profits are to be considered in claims and no investment for speculative purposes. In settlement of claims under this act there would be taken into consideration the salvage or usable value of any machinery, etc., purchased to equip wooden-ship building plants.

Miscellaneous Shipping and Shipbuilding Proposals

With the problem of ways and means to afford satisfaction to the wooden-ship builders out of the way, the Senate committee on commerce will undertake to consider, with due relation to one another, all the miscellaneous shipping and shipbuilding proposals that are before it. As a basis for general legislation dealing with the merchant fleet the upper branch of the Legislature has, of course, the bill that has been approved by the House, and as alternatives there are various bills put forward by members of the Senate. Senator Jones, chairman of the committee, has his own version of the plan that should be followed in the sale, charter and operation of vessels.

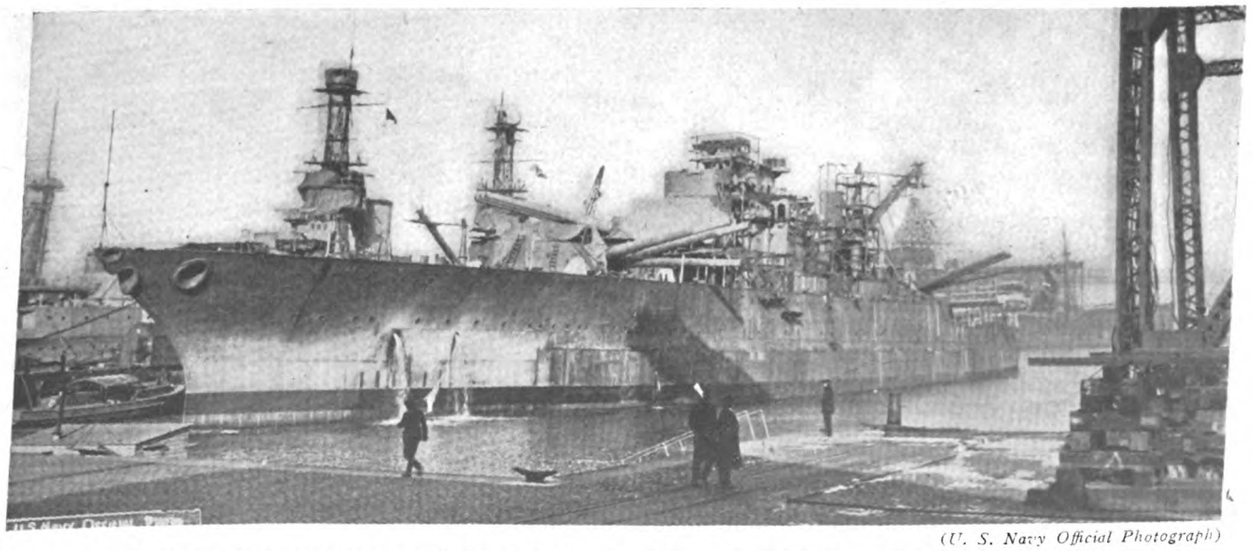
The House committee on merchant marine, while waiting for the crystallization of sentiment in the Senate on, the basic question of merchant marine policy and the future programme of the Shipping Board, will take up a number of miscellaneous bills dealing with the merchant marine, such as the bill sponsored by the chairman of the committee which has as its purpose the granting of permission for the transportation of a limited number of passengers on cargo vessels. Hearings will also be inaugurated in contemplation of reporting to the Legislature with a recommendation for passage a bill providing for the classification of vessels owned by the United States via the instrumentality of the American Bureau of Shipping and for the recognition of the Bureau as the official agency of all the departments of the United States Government and all commissions created by the Government.

A Bill to Abolish "Commercial Bribery"

Ship outfitting and equipment interests will be required to exercise caution in the solicitation of business if Congress decides to give place on the statute books to a measure which has been put forward incident to a general movement at Washington to put an end to that form of salesmanship known as "commercial bribery." Contact with the shipping industry is to be established via a bill (H. R. 9572) introduced by Congressman Miller, and which would prohibit the payment of gratuities to the masters of vessels or other persons for the purpose of inducing or securing contracts for repairing vessels or furnishing vessels with supplies or other necessaries. "Any commission, bonus, gratuity, sum of money or other thing of value" may not be received or solicited directly or indirectly, under the terms of this bill for the purpose of inducing the making or placing of any contract, "express or implied."

Disposal of the Cape Cod Canal

While sentiment has grown in Congress in favor of divorcing entirely from railroad regulation or control the censorship of freight rates on inland waterways and coastwise shipping routes it is interesting to observe the simultaneous growth of a movement designed to place within the ownership and management of the national government privately controlled waterways that might be denominated "keys" in the field of waterborne commerce. The most notable example is found in the effort to authorize the acquisition and operation by the United States of the Cape Cod Canal. This is provided for in the bill known as S. 2083, the recent hearings upon which before the Senate committee disclosed interesting details as to the strategic importance of this waterway and the volume of commerce for which it affords a short cut.



(U. S. Navy Official Photograph)

United States Battleship *Tennessee* Nearing Completion at the New York Navy Yard, Brooklyn, N. Y. Length, 624 Feet; Extreme Beam, 97 Feet; Mean Draft, 30 Feet 6 Inches; Displacement, 32,000 Tons; Horsepower (Electric Drive), 28,000; Speed, 21 Knots; Armament, Twelve 14-Inch and Fourteen 5-Inch Guns

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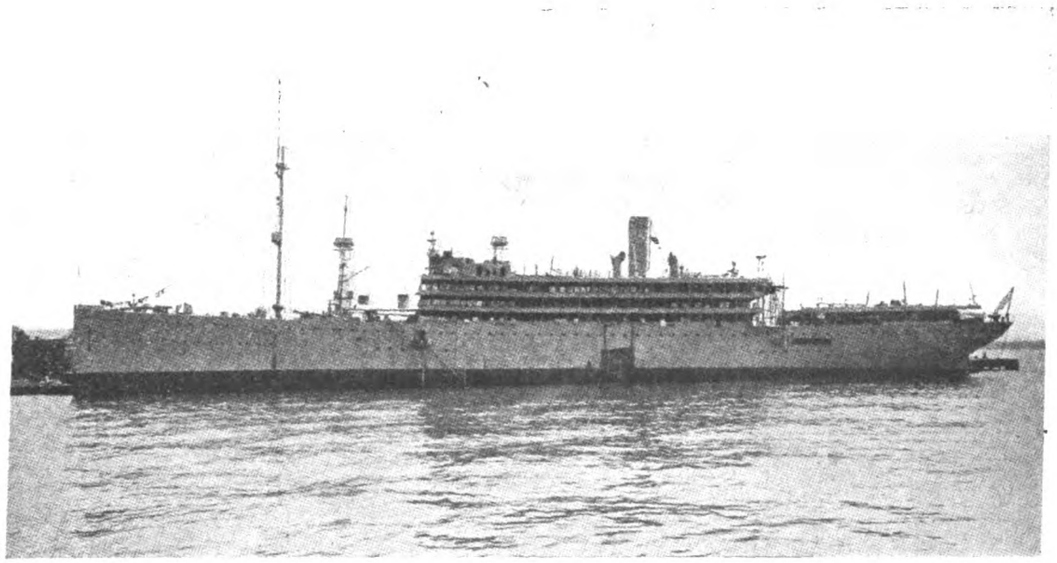

Fig. 1.—U. S. S. *Henderson* in Commission. Patch Is Over Twice the Size of Stabilizer

Non-Rolling Passenger Liners*

Observations on a Large Stabilized Ship in Service, Including the Plant and Economies Effected by Stabilization

BY ELMER A. SPERRY

NOW that it has been adequately demonstrated in the case of a number of important installations that a ship can be guaranteed against all rolling, a great forward step is possible and a new era opened up for the American passenger-carrying service. Plans are already in progress for an extensive adoption of the new principle, so that the benefits and economies resulting from a ship guaranteed against roll will be available to the traveling public.

In all previous attempts to prevent rolling the equipment has operated on the passive principle, depending on a certain amount of roll for the stabilizing moments, and the amount by which the roll has been reduced has never been satisfjactory, nor have the means themselves been practicable. Another difficulty is that the phase lag is found to be insurmountable, the stabilizing effect—such as it is—arriving "the day after the fair."

The active gyro stabilizer solves the problem and works entirely independently of the motion of the ship. Delivering full counter-moments to a motionless ship, it is free to deal directly with the wave slopes themselves, i. e., with the rolling increments of the sea as they are in the process of developing, even before incipient rolling has set in. The active stabilizer thus acts as a simple preventive of rolling, working in harmony with the slow period of the ship, yet dealing alertly with each increment as it arrives, irrespective of magnitude or direction; holding the ship most satisfactorily upon an even keel; demonstrating how little is really required to keep a ship from rolling, or, rather, from beginning to roll, if only a basically preventive method is employed.

With the complete solution thus in hand, accomplished with a small and simple equipment, it is believed that the older passive types, with their great weight, fractional results and uncertain operation, will become obsolete.

The difficulty with all of the older passive types can be reduced to an extremely simple proposition: With all of these methods of attack, a pound weighs only a pound and its effectiveness is measurable in simple terms of the lever-arm of its application, or the distance from the center of oscillation of the ship at which the moments become effective. This is the reason for the excessive and even prohibitive weights necessarily present in all these methods of reducing the roll of ships. On the other hand, in arriving at the powers available to stabilize the ship with the gyro, every pound is multiplied by the velocity of the particle, so that a comparatively few pounds are actually capable of doing the work of tons. With the active gyro this is all held in phase, and is available for the important purpose of holding the ship free from even the beginnings of roll.

Stresses in Hull from Stabilizer

Those unfamiliar with the subject, and even some naval architects, have feared that the forces and stresses involved might endanger the ship's structure in case of a heavy storm. The exact nature and magnitude of these stresses are perfectly well understood and have now been brought under careful observation in quite a large number of equipments in actual service. We are therefore speaking from a wide range of accurate knowledge on this important item, and it will be interesting to know that the conclusions by the highest authorities are that a ship which freely rides the waves with its mast held vertical, being completely stabilized by the little gyro equipment in her hold, is subjected to less than one-fourth and often less than one-sixth of the very large strains present when it is allowed to roll under exactly the same storm and weather conditions and with the heading unchanged in

* From a paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

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the same sea. With the gyroscopic stabilizer equipment on board, we have the unique situation of being able instantly to throw it on or off, in action or out, at will, by stopping its slow precessional movements, so that we can observe exactly what happens under the two conditions and repeat each condition as often as we choose and hold each under complete observation as long as we choose, under any given sea or weather condition. And just such tests as these have been repeatedly made and studies pursued until they are well known and understood. Thus the presence of the stabilizer on the ship reduces and holds to a very low value the stresses and strains which in the case of an unstabilized ship in storms often rise to high and dangerous magnitudes.

Everyone is familiar with the groanings, creakings and weird noises that are always present in heavily laboring or rolling ships. These illustrate the stresses and strains to which she is being subjected. Imagine the sensation when the stabilizer is thrown into action and these sounds cease forthwith, positively demonstrating that the heavy stresses have vanished. The stabilizer thus becomes one of the greatest safety devices yet invented, imparting absolute security to the great hull and structure of the ship and materially prolonging its life. All of this, of course, is wholly outside of the consideration of comfort, which is one of the prime reasons for the installation on passenger ships.

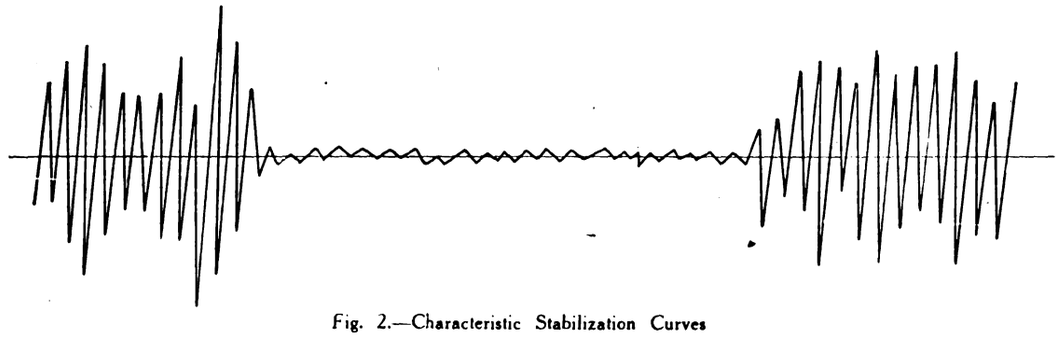

Fig. 2.—Characteristic Stabilization Curves

STABILIZED SHIP A DRY SHIP

This great authority went further and stated something that our highest authorities in this country then doubted, namely, that as soon as a ship was stabilized in a storm and rolling was prevented, that ship would not ship seas, but her decks would immediately begin to be dry and would remain dry. Although we did not at the time believe that this could possibly be true, our universal experience since we have had these installations in operation demonstrates the absolute truth of the statement, as the result of many observations and experiments, incidentally showing the great insight of Sir William.

Even some excellent authorities, before actually having the unique and extremely interesting experience of being aboard a stabilized ship, have confused a stabilized ship with a dock, expecting the waves to pound the ship when stabilized, and it is with great surprise and satisfaction that they have repeatedly discovered just the reverse to be true. A stabilized ship invariably rides the sea, gradually rising and falling with the sea with a wonderful degree of gentleness. Her masts quickly come to the vertical, and all pounding and splashing disappear as soon as stabilizing sets in.

"HELM" REDUCED IN HEAVY WEATHER

Other facts have been learned from the performance of the stabilizer in heavy weather. It is found actually to contribute a number of definite economies in the operation of the ship. Anyone who has ever undertaken to pilot a heavily rolling ship and to hold her to her course has realized the enormous amount of "helm" that is constantly required, and the resulting very sinuous course that the ship takes in spite of the best efforts the helmsman can make under these conditions.

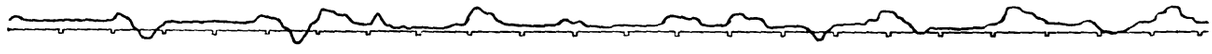

Fig. 3.—Automatic Record; Helm Required, Ship Not Rolling (Straight Line Indicates Rudder Center with One-Minute Intervals as Jogs)

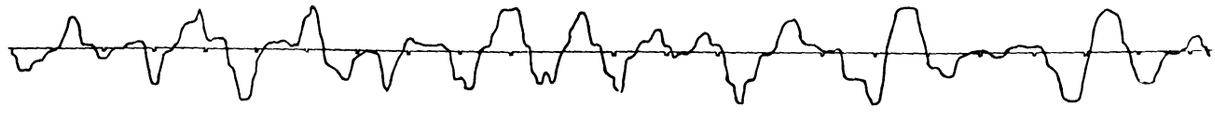

Fig. 4.—Automatic Record; Helm Required, Ship Rolling Heavily

In this connection it will be interesting from a technical standpoint to know that some time before the first stabilizer equipment was installed by the United States Navy the great English naval architect, Sir William White, was brought to this country in consultation on this subject. He stated, after careful review of the facts, that from the naval architect's standpoint the strains introduced by the gyroscopic stabilizer in holding a vessel absolutely free from roll were insignificant, and that if we laid hold of a single frame of an ordinary steel ship we would have a factor of safety of about six, and furthermore that these strains and stresses were only a small fraction of those existing in the hull and general structure of a ship when rolling in a storm.

No pains have been spared in studying this important phase of the contribution of the stabilizer. The gyro compass, with its enormous directive power, enables automatic records to be made of the most minute orientation of the ship. These have been secured and also simultaneous graphic records of the amount of helm being used by the ship, also automatic, so that there could be no question as to exactly what was happening. The study of

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these records has been full of interest, developing an accurate method of analyzing and aiding to establish the losses under this division.

Fig. 2 shows a characteristic stabilization curve. Figs. 3 and 4 are helm records made on a 16,000-ton ship with the same series of helmsmen at the wheel. Fig. 4 clearly shows the threefold losses due to rolling: First, the sinuous course; second, the bad angle of attack and the wider path; and third, the direct retardation due to increased helm.

Operating engineers and naval architects know that even a very slight amount of "helm" acts as a tremendous retarder in the forward progress of the ship, and especially is this emphasized when a very large amount of helm has to be constantly employed. This slows down the ship, uselessly wasting a great deal of the propulsive power of her engines. Again, the sinuous course that is invariably steered by a wallowing ship causes it to travel a considerable extra distance, always accompanied with a "bad angle of attack," causing a large extra power consumption. A stabilized ship is practically self-steering. This comes as a sort of a bi-product of stabilization, the stabilized ship requiring practically no helm, regardless of weather.

But there is a still greater source of power waste in rolling ships. As the hull constantly oscillates back and forth, its form-lines encounter and constantly displace laterally, with extra friction of impact, hundreds, and even thousands, of tons of water, and this persists, going forward with every roll. This, in connection with the extra wetted surface involved, added to the extra streamline losses and skin friction impingement, especially when bilge keels are present, amounts to losses of very great magnitude in terms of actual horsepower wasted. Model experiments and resulting calculations indicate that these losses are much higher than have been supposed. For a 15,000-ton vessel at 18 knots—away inside the maximum roll—this loss may easily reach from 1,000 to 1,200 horsepower, and this power is absolutely dissipated and wasted.

Power Saved in Stabilized Ship

Just here the stabilizer steps in with a saving of nearly all of this—practically the entire amount, minus the small and comparatively insignificant quantity of power that is required to keep the gyro wheel spinning in a vacuum. In the course of a very few voyages this power saving in terms of fuel saving amounts to enough to pay for the entire stabilizing equipment.

Very full corroboration of this is found in the service performance of a fast passenger and cargo ship, by taking ten consecutive trips over the same course in the same direction with almost identical load conditions and under conditions of constant propeller revolutions. These trips are sufficiently long—4,600 miles—to be convincing in the results shown. These data have been plotted in revolutions per knot (see Fig. 5) and give an interesting and positive indication of the retardation of the ship owing to weather conditions. A very great amount of the losses in headway due to the retardation effect of the disturbances discussed above will be entirely eliminated by full stabilization. Let us examine what this means in dollars. Suppose the operating expense per 24 hours to be $6,000. The extra expense—that is, the expense over and above the average—in the stormy months amounts to not far from $100,000. This, taken with the amount saved through elimination of bilge keel losses, develops an earning capacity of the stabilizer of not far from 100 percent per annum. All of this is over and above the many other important gains, both direct and indirect, resulting from the stabilizer installation.

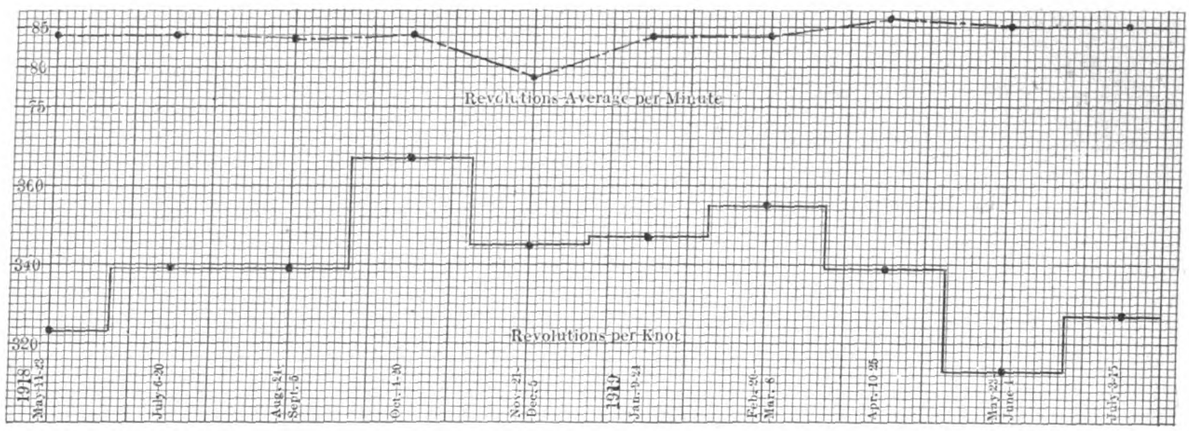

Fig. 5.—Data from Engineer's Log of Cargo and Passenger Vessel Showing Retardation by Weather Conditions in Winter Months

The stabilizer achieves another economy of very great significance to both the operator and the passengers of fast ships. This is the practical avoidance of the necessity for slowing down ships in stormy weather or when heavy seas prevail, the ships being able to make practically the same time under storm conditions. This has been repeatedly demonstrated and is a result so startling that, when first experienced, it has often been claimed as an original discovery by the skippers of stabilized ships.

So insignificant are the stresses required to prevent all rolling that it is interesting to compare them with or to state them in terms of the specific loading permitted by the underwriters. Take a concrete case of the transport *Henderson*, of 10,000 tons displacement, 488 feet length, with maximum beam of 48 feet and draft of 19 feet 9 inches—the allowable load per running foot for the section where the stabilizer is located is 14.5 tons. The load due to the weight of the stabilizer plus the maximum gyroscopic stabilizing moments, figured as load upon the vessel, is at maximum only 10 tons, and with average stabilizing moments about 6 tons per running foot. In other words, the stabilizer loads are much less than normal cargo loads. Some of the vessels carrying heavy machinery to France were loaded as high as 28 tons per running foot. The foregoing makes clear in a very practical way the relation these forces bear to the vessel's ordinary loads.

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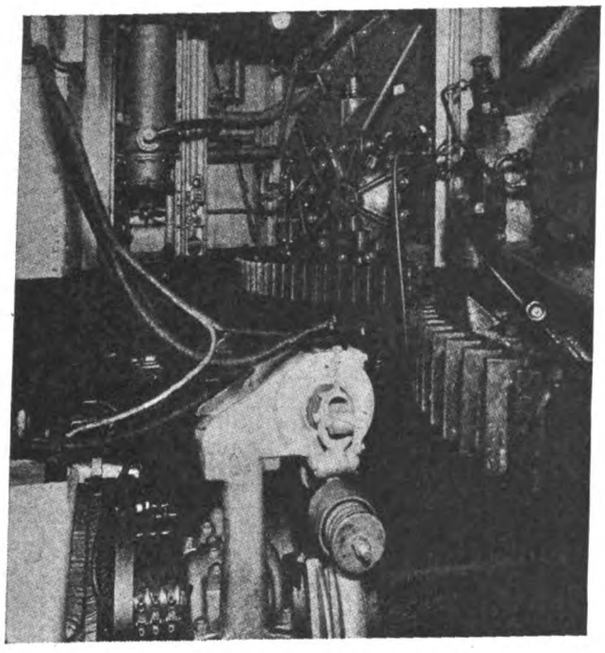

Fig. 6.—Stabilizer Room on U. S. S. *Henderson*. Main Gyros on Right, Precession Motor in Foreground

Another definite advantage secured by the stabilizer is the elimination of the bilge keels. Dealing only as they do with velocity squared, they can never be of service other than in the heaviest rolling—at all other times they are a positive menace. The well-known drag of bilge keels in perfectly calm weather is not only ever present, but represents positive losses, even in excess of those calculated. This has now been positively observed in the case of a large 20-knot ship, the performance with and without bilge keels for the same shaft revolutions, loading and trim being known. Moreover, a ship is never trimmed very accurately longitudinally, giving the bilge keels a frontal attack component with the attendant eddies, consuming additional power of no small magnitude.

Bilge Keels Eliminated

In rough weather the bilge keels afford an extra opportunity for the waves to lay hold of the vessel in rolling. Recently it has been definitely determined that the power required by bilge keels under the condition of pitching, even in a moderate sea, increases the propelling power to a point much beyond what has been supposed. In the case of a 10,000-ton vessel with standard keels, even with moderate pitching, an increase propelling power of about 9 percent has been observed. In a stabilized ship it is possible to eliminate bilge keels. There should be no hesitancy in omitting keels, as an exceptionally large and successful fast passenger ship has been operated without bilge keels for years.

A reduction in stresses of the propelling machinery of a stabilized ship represents another important gain, especially in the case of twin-screw vessels where the windward propeller is held very much more satisfactorily to its duty—not only saving power, but preventing the racking strains due to overspeeding when the screws are "rolled out." The efficiency of a propeller falls off abruptly as its blades even approach the surface, especially where the dip of the waves allows the slightest aëration of the water. For efficiency a propeller requires to be kept down in stiff water.

Prevention of deterioration in cargo applies especially to ships carrying live stock. Figures have been furnished by a concern transporting horses during the war, showing that, in a heavy storm during a single trip, their losses per trip often amounted to $30,000 or $40,000, a sum sufficient in a short period to equip the vessel with a stabilizer.

The ability to roll the ship has proved in actual experience to be important in case of emergency to free the vessel from sand and mud banks, by opening the contacting crevices and gradually liquefying the incumbent mass. This has been discussed in a former paper, also the field of the active gyro in rolling ice-breakers and preventing them from freezing in when cutting through rivers and harbors during the winter months. The most important use for rolling, however, is as an aid to gunnery.

Sea Experiences with Stabilized Vessels

As outlined, we have been accumulating a large amount of actual sea experience with various sized equipments. The war has seriously interfered with the work, but even during this period the Navy has allowed us to complete the largest gyro equipment yet attempted; and though the installation has been retarded by the ship being in constant transport service, this fact has offered additional opportunity for final testing. Fig. 1 gives a very good view of the U. S. S. *Henderson*, a transport built at the Philadelphia Navy Yard. Fig. 6 shows a corner of the gyro room on the *Henderson* with the precession motor in the foreground, and Fig. 7 shows the little control room with the rotary for generating A. C. current for spinning the gyros in the background. Directly in front of the rotary converter is the vertical gudgeon bearing which transmits the stabilizing moments through the ordinary steel decking to the ship's structure. This ordinary steel decking is found to carry the stabilizing moments with a large factor of safety. In the foreground is the special control gyro for the ordnance tests. In this case the gyro may operate in a single period successively as a stabilizer or as rolling equipment. Fig. 8 shows a curve of the *Henderson* automatically rolled by her special equipment when at sea under full headway.

This ship has operated with as high as 11,500 tons displacement, and the stabilizer has been repeatedly operated under overload conditions without difficulty, the journals running with perfect temperature control under the heaviest duty, including overload conditions. Even dif-

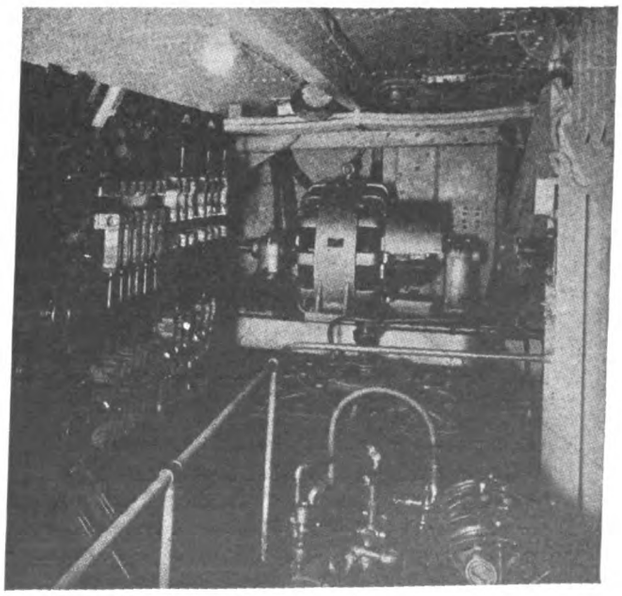

Fig. 7.—Control Room, U. S. S. *Henderson* Stabilizer

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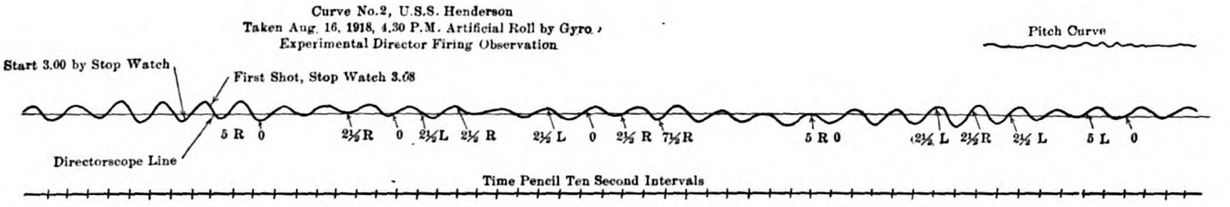
Curve No. 2, U.S.S. Henderson
Taken Aug. 16, 1918, 4.30 P.M. Artificial Roll by Gyro
Experimental Director Firing Observation
Pitch Curve
Start 3.00 by Stop Watch
First Shot, Stop Watch 3.08
5 R 0
2½R 0 2½L 2½ R
2½ L 0 2½ R 7½R
5 R 0
2½ L 2½R 2½ L 5 L 0
Directorscope Line
Time Pencil Ten Second Intervals

Fig. 8.—Automatic Constant Roll Imparted to U. S. S. *Henderson* at Sea

ferent lubricants have been tried, all giving about the same results; in fact, the plant, since the journals have been worked in, has operated normally in service, and the records show that the guaranteed stabilizing moments have been easily developed.

Fig. 9 shows a plain gyro oil bearing that has operated perfectly. This bearing has received over 100,000 precessions, many under overload conditions. This bearing was removed for photographing. The original tool marks and scraping are plainly visible. The oil groove to the left, with its far end partially stopped, and the corresponding diametrical one are the feeding grooves proper; the others are for flushing the revolving shaft surface with cooling oil and, together with the exterior holes, serve to hold the bearing under perfect temperature control as described.

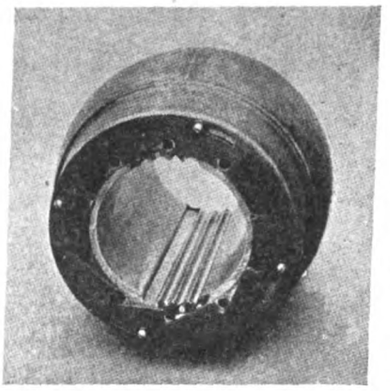

Fig. 9.—Main Gyro Bearing Photographed After 10,000 Precession Loads, Tool Marks Still Visible

This equipment has undergone additional protracted tests as an ordnance fitting, reaching results in this connection which are extremely interesting; operating in this part of the work in conjunction with the base equipment of our latest fire-control system. The exacting nature of these tests and their severity have contributed in no small measure to another extremely interesting result as follows: The complete knowledge we now have of the behavior of these equipments and the measured results and records have placed us in a position to guarantee unqualifiedly the stabilization of practically any ship to accurate specification and also the equipment by means of which this important result is secured.

Plastic-Arc Welding Applied to Ship Construction and Repair

BY J. O. SMITH*

PLASTIC-ARC welding was being developed and used on some of the larger eastern railroads for a long time previous to the outbreak of the war in 1917. As a result of its successful application in welding heavy cast-iron locomotive and other parts, the Navy Department engineers turned to the plastic arc as a means of repairing the damaged German ships. The successful repair of the large cast-iron cylinders and other parts of the German ships has led naturally to consideration of arc welding in the manufacture and repair of metal products and parts of all kinds. The attention of engineers generally has been attracted by its possibilities, and the great achievement of successfully repairing the damaged ships has naturally given the subject great prestige among shipping and shipbuilding interests.

* Engineer, Wilson Welder & Metals Company, New York.

Use of the Arc in Shipbuilding

When the matter of welding in connection with ship construction is considered, immense possibilities immediately suggest themselves. It has been definitely determined by exhaustive technical study and experiment that welding can be satisfactorily employed in ship construction, that ship plates joined by welding will be as strong or stronger than the original metal at the welded joint, and that welding can be employed for ship construction work at a saving of 25 percent in time and 10 percent in material, as compared with riveting.

In actual figures, as determined by experiments of the Emergency Fleet Corporation's electric welding committee, the saving in rivets and overlapped plates would amount to 500 tons in weight on a 9,500-ton ship, where welding had been used.

Further investigations by this committee led to the conclusion that electric welded ships could be built at least as strong as riveted ships; that plans for ships designed to be riveted might easily be modified, to adapt them for extensive electric welding, and thus save in the cost and time of hull construction; that ships especially designed for electric welding could be built at a saving of 25 percent over present methods and in less time.

An electrically welded ship is credited with many advantages over a riveted ship. In a 5,000-ton ship about 450,000 rivets are used. A 9,500-deadweight-ton ship requires 600,000 or 700,0000 rivets. By the welding process the saving in labor on the minor parts of a ship is reckoned at from 60 to 70 percent on the hull plating and other vital parts, the saving in labor, cost and time of construction by welding is conservatively placed at 25 percent.

Lloyd's Investigations

Considerable investigation of the subject of welding instead of riveting has been made in England by Lloyd's Register of Shipping particularly with regard to formulating rules for the application of electrical welding to ships. As a result of the investigations and experiments made by the society's technical staff, it was determined that the matter has assumed such importance as to warrant the formulation of provisional rules for electrically welded vessels. These have been issued for the guidance of shipbuilders by Lloyd's Register.

The experiments conducted in England followed three well-defined lines of investigation; the determination of the ultimate strength of welded joints, together with their ductile properties; the capability of welded joints to withstand alternating tensile and compressive stresses, such as are regularly experienced by ships; and microscopic and metallurgical analyses to determine if a sound fusion were effected between the original and added metal.

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It was determined that the tensile strength of the welded joints was from 90 to 95 percent of the original plates, as against a strength of from 65 to 70 percent in riveted joints, showing a margin of 25 percent increased strength in favor of the welded joints.

The result of the tests to determine the elastic properties of welded joints indicated that there was a slight difference in favor of the riveted joint. The art of welding has made such great strides recently, however, that it is believed entirely possible to make a welded joint in ship plates that will stand as great a number of reversals of stress as a riveted joint.

The microscopic and metallurgical analyses determined definitely that a good, solid, mechanically sound weld was made between the original and the added metal, the two metals having been fused together so perfectly that no line of demarcation could be seen.

The rules so far promulgated by Lloyd's have been necessarily of a tentative nature and will no doubt be modified and enlarged from time to time in view of the experience that will be gained after a few welded ships have been in service for a time.

In addition to the increased cost of riveting as compared with welding, it is nearly always true that there are a certain number of imperfectly fitted rivets, that do nothing more than add weight to the ship. The main purpose of a rivet, of course, is to bind two or more thicknesses of plate together, but if the rivet is bent or loses part of its head in the riveting process, or otherwise fails to function properly, there is no method by which such faults can be corrected after the rivet cools. Such defective rivets must be removed entirely if the importance of the riveted part requires a perfect joint. When it is considered that a 5,500-ton ship requires approximately 450,000 rivets to bind the various parts and plates, and also that a certain percentage of these rivets are not fulfilling the purpose for which they were intended, it is quite evident that practically every ship is burdened with a good-sized load of dead, useless weight. Such defective rivets are, in fact, more than a useless weight, in that they are a menace to the ship, for, while they have been built into the ship for a purpose and are supposed to be fulfilling that purpose, there is no telling how much the ship has been weakened structurally by their failure.

Reasons for Defective Rivets

There are many reasons for defective rivets, and one of the greatest of them is inaccessibility, and the consequent difficulty on the part of the riveter to put them in place properly. Then, too, there is no certainty that rivets are at a proper workable temperature. If they are too cold, the pneumatic hammer now generally used in riveting is unable to round off the end of the rivet properly and the plates are not bound together as they should be.

In many cases, when leaky rivets are discovered, the present-day method is to weld the defective spots, which immediately brings up the natural question why it would not be advisable to weld the plates at first.

The ability of a welder, using a direct-current, low voltage arc with automatically regulated current, to make sound mechanical welds in cramped, confined spaces on overhead or vertical walls—in fact, anywhere a man and a wire can go—naturally suggests that welding ship plates together should be the primary operation in shipbuilding.

A New Development in Hoisting Machinery

Horizontal and Vertical Movements of Loads Controlled by Single Drum—Dead Load Balanced by Counterweight, Thus Reducing Power Required for Operation

BY WARREN TRAVELL*

So much attention has been given during recent years to the design of hoisting machinery and the various types have been so highly perfected that an improvement in such apparatus embodying a new principle of operation is unusual.

Such an improvement in hoisting equipment has recently been developed by the writer and is applicable to all installations where vertical hoisting and horizontal traversing of loads are required. A single drum is used for these two movements in place of the customary two drums. The shift between vertical and horizontal motion is accomplished by means of a lever which controls a pair of rope grips.

Another important feature of this apparatus is that during the hoisting operation the entire dead load of the skip or bucket and half the live load is balanced by a counterweight, which reduces the size of the hoist and motor and also effects a large saving in the amount of power required as compared with other types of apparatus in which no counterweight is used.

During the operation of lowering, the motor is working to raise the counterweight, thus obtaining a control somewhat similar in effect to the well-known dynamic braking and much safer in operation than the common method of lowering with a brake. As the hoist drum is rigidly keyed to its shaft, no friction clutch is required and freedom is obtained from the troubles incident to this device.

This new type of balanced hoist and transporter is adaptable for use on hoisting towers, cargo cranes, traveling bridges, cable-ways and, in general, on all hoisting apparatus in which there is a free hoist and horizontal movement of the load. For grab-bucket work, there is required for the holding line an additional drum which may be of the counterweighted type, without connection to the motor. The advantages of this improved hoist may be briefly expressed by the statement that it uses one drum less and about half the power of the more common types of apparatus doing similar work.

In connection with this balanced hoist, another interesting improvement consists of an extensible boom, which is especially suited for use on cranes loading and unloading vessels. The boom may be extended or withdrawn in the direction of its own length and gives minimum interference with the stays, lines and wireless aerials of a vessel. An important feature in the design is the means adopted for paying out at a predetermined, varying rate of the ropes supporting the outer end of the boom. When used in combination with the balanced hoist equipment, the hoisting apparatus is operative at all points of extension of the booms. The slack rope resulting from the drawing-in of the boom is taken up by the counterweight. This enables the crane to handle freight on the pier while vessels are being moved alongside.

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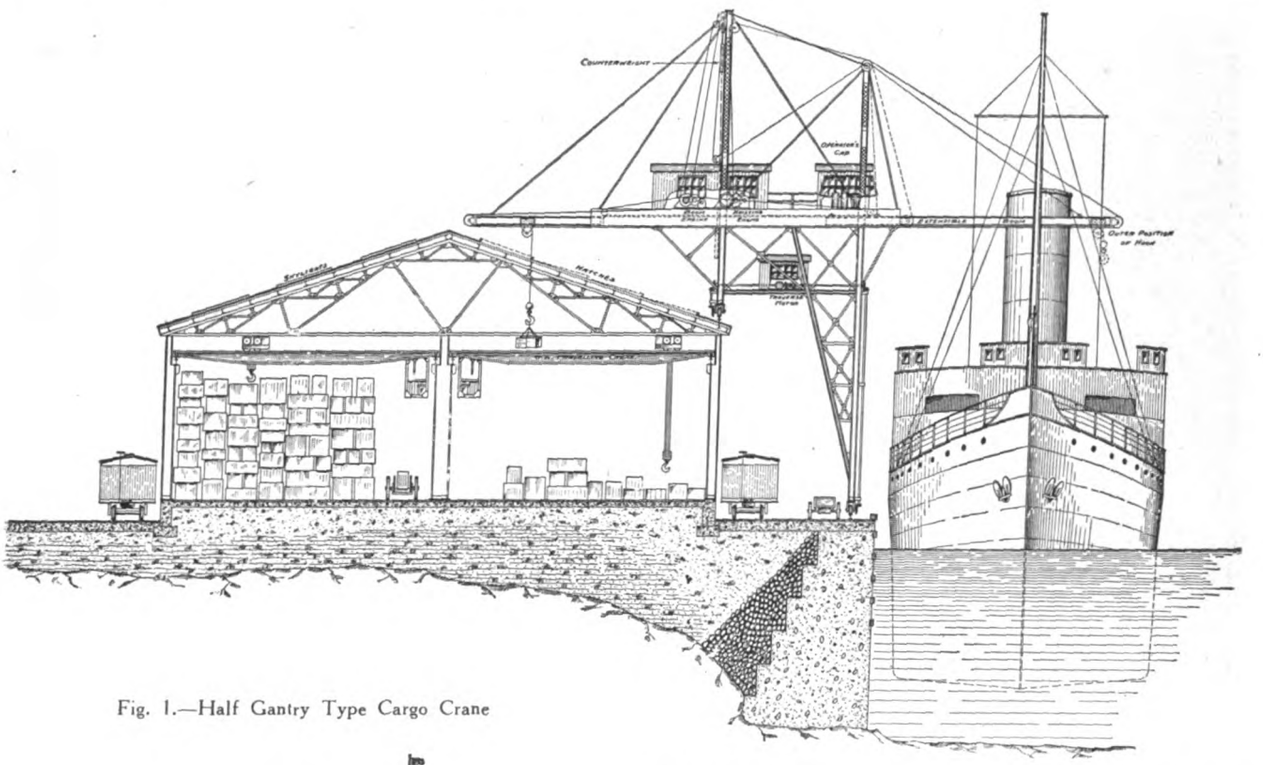

Fig. 1.—Half Gantry Type Cargo Crane

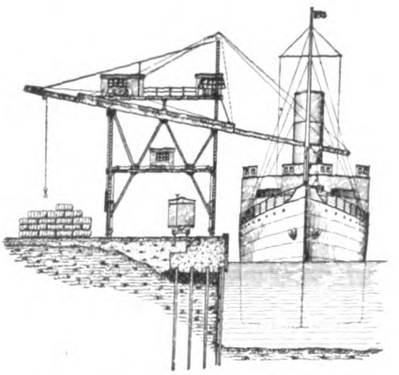

Fig. 2.—Full Gantry Cargo Crane

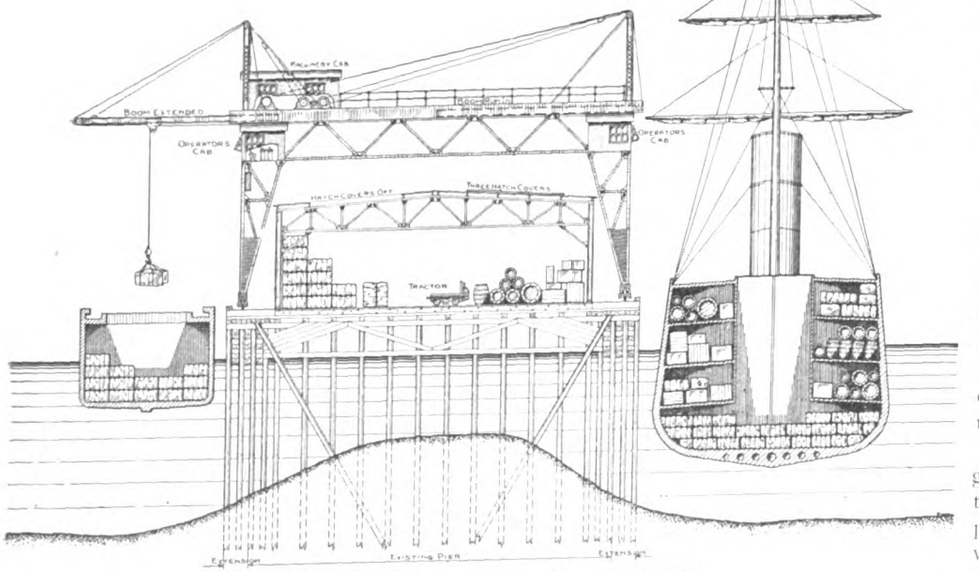

Fig. 3.—Special Type of Crane Spanning the Pier

The accompanying illustrations show three types of cargo cranes equipped with these improvements. Fig. 1 is of the half-gantry design with its short leg running on the roof of the freight shed. The space alongside, or "apron," may be of any reasonable width, permitting the installation of a driveway and one or more railroad tracks. Such a crane by operating through hatches in the freight-house roof can handle freight directly between the vessel and the shed, railroad cars and trucks. For ordinary service the crane has a capacity for handling loads of three tons at a speed of about 400 feet per minute and a traversing speed along the pier of 150 feet per minute.

To reduce manual handling to a minimum, the shed should be equipped with overhead traveling cranes or equivalent apparatus which will cover the entire floor area and make it possible to pile freight to a considerable height. Such auxiliary cranes may be used for the loading and unloading of trucks, the sorting and distributing of incoming freight, and stacking of outgoing freight in readiness for the next vessel.

Fig. 2 shows the full gantry with an inclined extensible boom. This design permits of a reduction in weight of structure from that required for a hori-

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zontal boom and economizes power consumption by equalizing the work of the motor during hoisting and traversing.

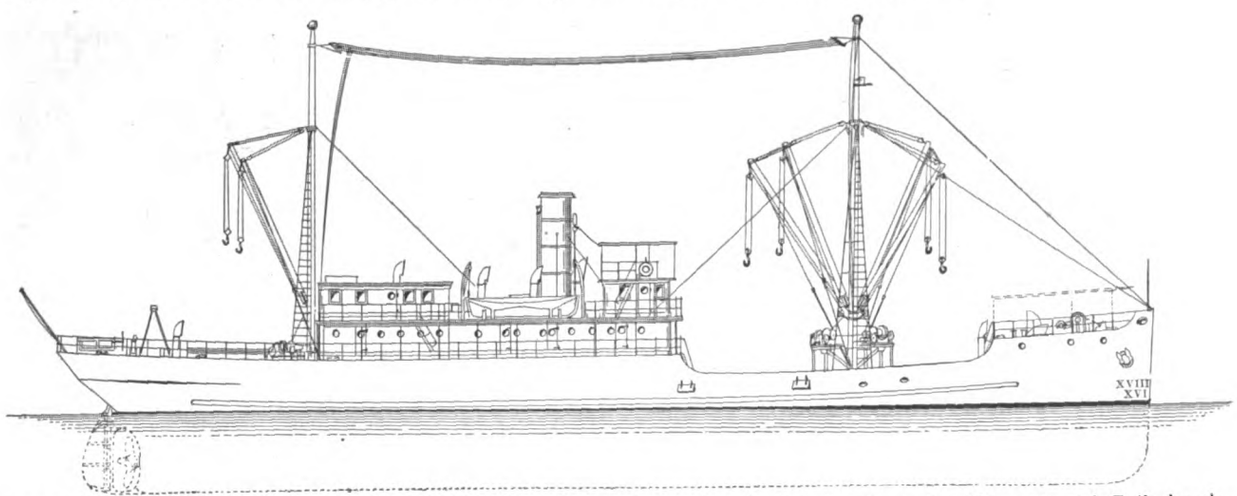
In order to reduce to a minimum the length of time during which a vessel is at dock, a sufficient number of cargo cranes should be installed so that there will be a crane available for operating at each hatch of a vessel.

The type of crane shown in Fig. 3 is adapted for use on existing piers where the freight shed occupies practically the whole width of pier and the structures have not been built strong enough to carry the additional loads which would be imposed on them by cranes traveling on the roof of the building.

The only changes required for the installation of this crane are the construction of an additional narrow strip of pier along each side of the building and the cutting of hatches in the roof of the pier shed. The hatch covers, which are of raintight design, are handled by the crane hook.

This crane has a counterbalanced hoist and two extensible booms, which give a means for handling freight directly between barges or lighters on one side of the pier and a vessel on the opposite side, as well as to and from the freight house.

The more general installation in our ports of up-to-date cargo cranes and auxiliary equipment by reducing the cost of handling, saving the time of vessels and increasing the handling capacity of the piers, will help materially in reducing the present high cost of commodities.



S. S. *E. D. Kingsley*, of 1,260 Tons Deadweight, Designed by Cox & Stevens for the Kingsley Navigation Company and Built by the Canadian Car & Foundry Company, Ltd.

Steel Cargo Steamer of 1,260 Tons Deadweight

THERE has recently been completed by the Canadian Car & Foundry Company, Ltd., which has offices at 25 West Thirty-third street, New York city, a 1,260-ton steel cargo steamer named the *E. D. Kingsley*. The designs for this vessel were made by Cox & Stevens, naval architects, New York. She has a speed loaded of about 10 knots, and is owned by the Kingsley Navigation Company.

Classification is by Lloyd's Register of Shipping, the dimensions being as follows:

Length overall	210 feet
Length between perpendiculars	200 feet
Beam	32 feet
Depth at side	17 feet
Draft extreme	15 feet 9 inches
Displacement	2,096 long tons

The propelling machinery consists of a triple-expansion engine of 880 indicated horsepower, with cylinders 16 inches, 25 inches and 43 inches diameter, with a common stroke of 30 inches. Two three-furnace Scotch boilers, 11 feet 11 inches diameter by 11 feet 3 inches long, furnish steam at a working pressure of 190 pounds per square inch.

The engine room equipment includes a condenser with a cooling surface of 1,200 square feet, a Reilly feed water heater and a Reilly evaporator.

The auxiliary machinery comprises the following:

Vertical simplex air pump, 7½ inches by 14½ inches by 8 inches, of the Worthington type.

Centrifugal circulating 8-inch pump, Morris Machine Works.

Vertical simplex main and auxiliary feed pumps, 8 inches by 5 inches by 12 inches, of the Davidson type.

Horizontal duplex fire, bilge and general service pump, 7½ inches by 7 inches by 10 inches, of the Worthington type.

Horizontal duplex oil transfer pump, 7½ inches by 7 inches by 10 inches, of the Worthington type.

Horizontal duplex sanitary pump, 5¼ inches by 4¾ inches by 5 inches, of the Worthington type.

Horizontal duplex evaporator feed pump, 3 inches by 2 inches by 3 inches, of the Worthington type.

It is believed by the designers that this particular vessel, of which an outboard profile is shown in the illustration, is of the type that will attract considerable attention, inasmuch as there is a great demand for steamers of relatively small size for coastwise trade, particularly among the islands and in South America.

Annual Meeting Institution of Naval Architects

The annual meeting of the Institution of Naval Architects will be held in London beginning on Wednesday, March 24.

MEETING OF ATLANTIC COAST SHIPBUILDERS ASSOCIATION.—The New York section of the Atlantic Coast Shipbuilders Association will meet at 6 P. M., January 14, at the Hotel McAlpin, New York.

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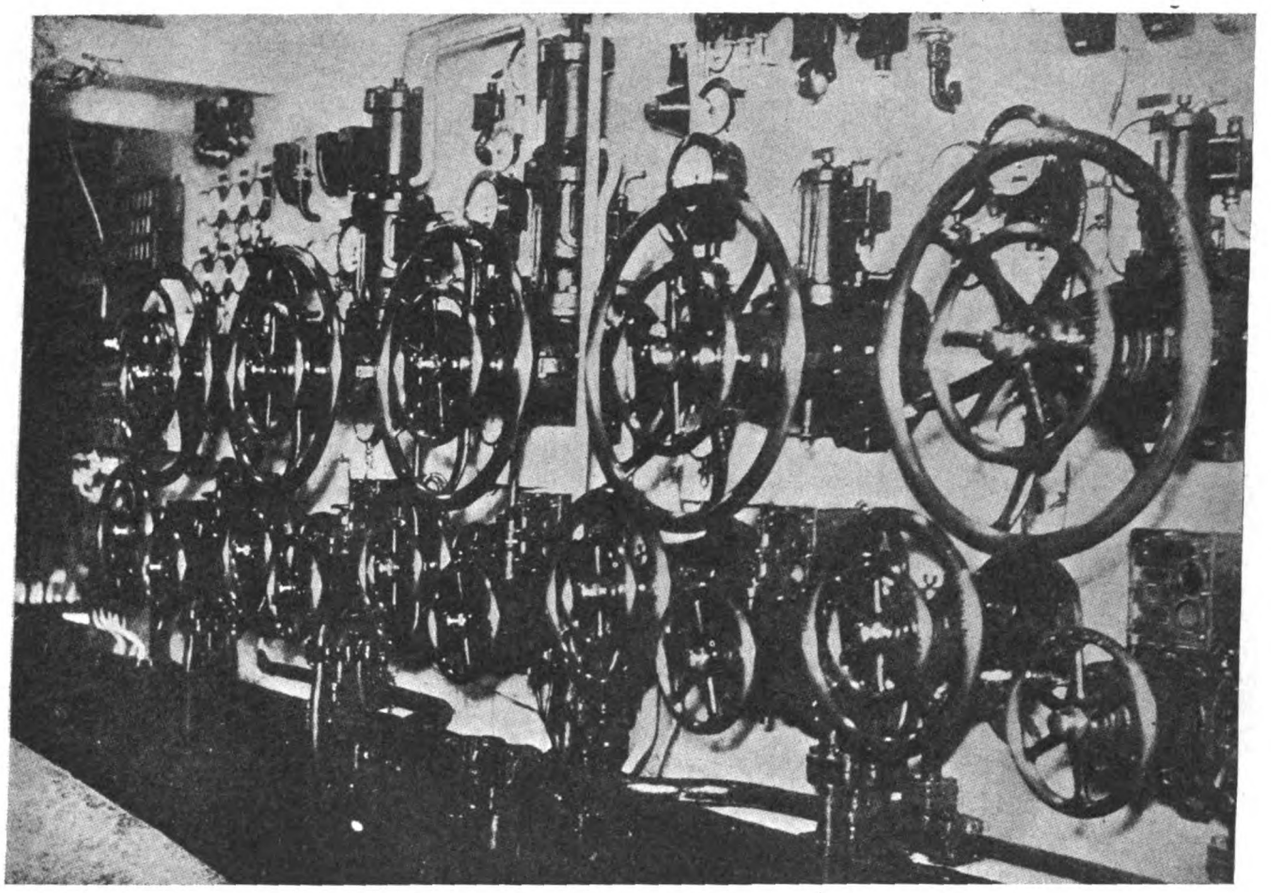

Fig. 1.—Arrangement of Hand Wheels of Maneuvering Gear on Working Platform in Forward Engine Room

Propelling Machinery of the Leviathan*

BY ERNEST H. B. ANDERSON

AT the outbreak of the war in 1914 the *Leviathan*, which was originally the *Vaterland*, the second of three large Atlantic liners which the Hamburg-American Steamship Company ordered to be built in Germany during 1911, had made one round trip between Hamburg and New York and had completed the outward run of her second voyage. The third vessel was not launched at the outbreak of the war, and it is highly improbable that she will be ready for service for some considerable time.

The *Leviathan* is the largest vessel ever completed.

* From a paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

TABLE I.—DIMENSIONS OF LEVIATHAN AND OTHER LARGE VESSELS

	Leviathan	Imperator	Aquitania	Mauretania
Builders	Blohm & Voss, Hamburg	Vulcan Co., Hamburg	John Brown & Co., Clydebank, Scotland	Swan, Hunter & Wigham Richardson, Wallse id on Tyne, England
Owners	U. S. Government	British Ministry of Shipping	Cunard	Cunard
Date of completion	1914	1913	1914	1907
Length overall	950 ft.	905 ft.	901.50 ft.	765 ft.
Length between perpendiculars	.....	880 ft.	865 ft.	760 ft.
Breadth	100 ft.	98 ft.	97 ft.	88 ft.
Depth, molded	63 ft.	62 ft.	64 ft.	60.33 ft.
Gross tonnage	54,190	52,117	46,500	32,000
Draft	38.50 ft.	35.50 ft.	36 ft.	33.50 ft.
Displacement	63,100 tons	57,000 tons	53,000 tons	38,000 tons
Type of engine	Parsons turbines	Curtis Parsons turbines	Parsons turbines	Parsons turbines
Number of shafts	4	4	4	4
Type of boilers	Watertube	Watertube	Scotch double-ended	Scotch double-ended
Number of boilers	46	46	21	21 D. E. 2 S. E.
Number of furnaces	138	138	168	192
Steam pressure	235 lbs. per sq. inch	235 lbs. per sq. inch	195 lbs. per sq. inch	195 lbs. per sq. inch
Total heating surface	210,440 sq. ft.	203,009 sq. ft.	138,595 sq. ft.	158,350 sq. ft.
Total grate surface	3,843 sq. ft.	3,763 sq. ft.	3,541 sq. ft.	4,048 sq. ft.
System of forced draft	Howden's	Howdens	Howden's	Howden's
Total S. H. P. of ahead turbines	65,000	61,000	60,000	68,000
Speed in service	22.50 knots	22.50 knots	23.50 knots	25 knots
Revolutions per minute	170	170	165	180

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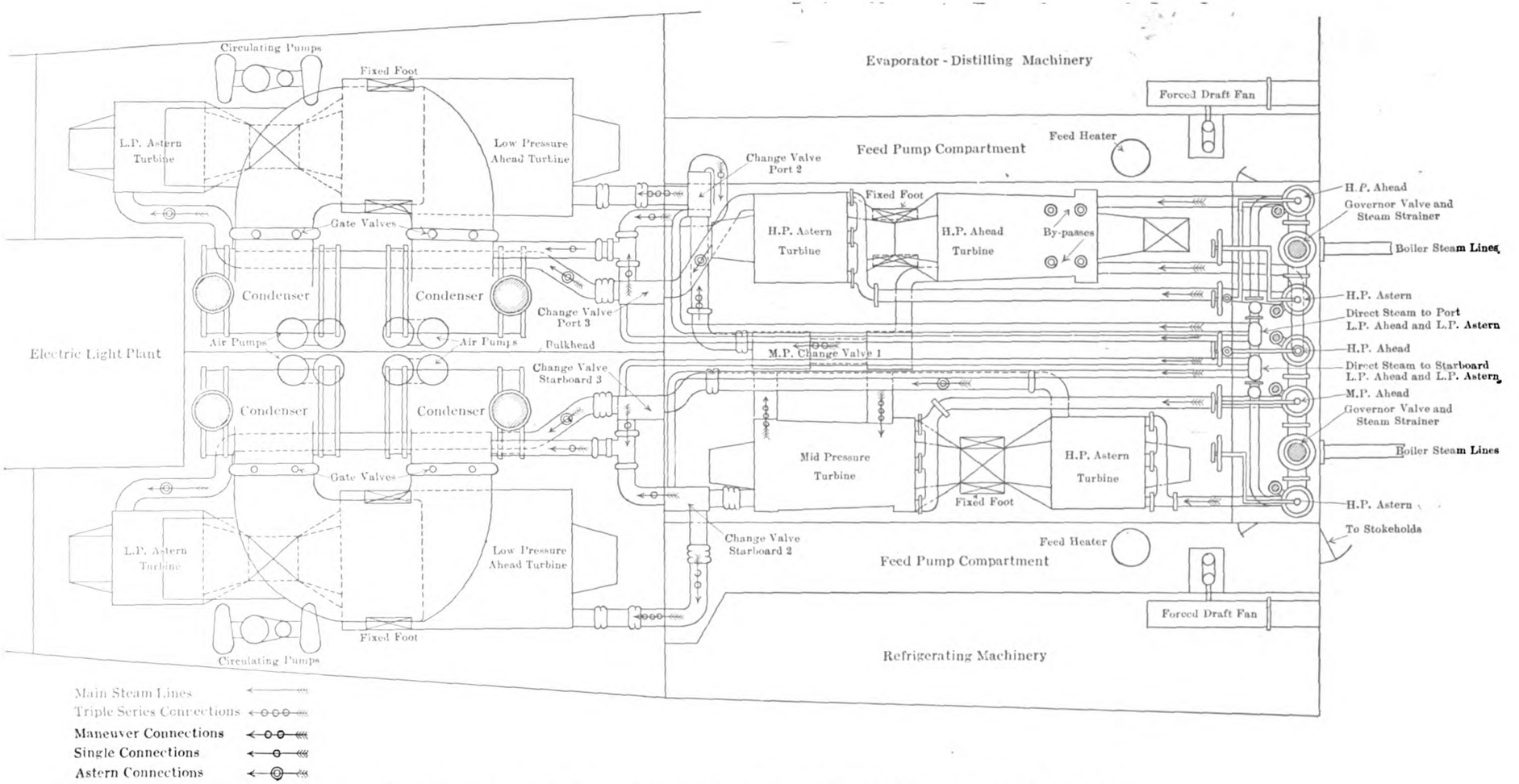

Fig. 2.—Diagram of the Engine Rooms of the *Leviathan*, Showing Steam and Exhaust Connections

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The list, Table I, gives the principal dimensions of the vessel and also comparisons with other similar vessels.

GENERAL ARRANGEMENT OF TURBINE MACHINERY

The vessel is driven by the Parsons direct type of steam turbine arranged on four shafts. The turbine installation consists of eight separate turbines with their respective rotors.

The go-ahead units, of which there are four, each driving a separate shaft, are arranged to operate in triple series, which is the arrangement adopted in all the large Parsons turbine-driven vessels built after the completion of the Cunard liners *Lusitania* and *Mauretania* in 1907.

The go-astern units, of which there are also four, are arranged to operate in parallel and consist of two independent sets for the two port and two starboard shafts, each unit of which drives a separate shaft. In other words, each shaft with its propeller wheel is driven, respectively, by one go-ahead turbine and one go-astern turbine.

The machinery installation contains many clever features, the chief being that under any extraordinary conditions which may arise at sea it is possible to operate the two turbines to any one shaft entirely independent of the other units. This means that it is hardly possible for any contingency to arise whereby the turbine installation can be entirely disabled. Further, all the interconnecting valves and pipes between the turbines are located on the lower half of the casings. The design of these valves, together with the hydraulic operation of the valve pistons, is such that any change can be carried out at sea without having to shut down or stop the vessel for any appreciable length of time.

The turbines are arranged in three separate engine room compartments, as shown on Fig. 2. The four units of the two inboard shafts are in the main or forward engine room, while the two turbines of each outboard shaft are in the two aft engine rooms, these compartments being separated by the fore-and-aft bulkhead down the centerline of the vessel. The high-pressure ahead turbine drives the port inboard shaft, and coupled directly to the aft end of this is a high-pressure astern turbine. The mid-pressure ahead turbine drives the starboard inboard shaft, and coupled directly to the forward end of this unit is the other high-pressure astern turbine. The two low-pressure ahead and two low-pressure astern turbines drive the outboard shafts, each pair being arranged in one of the separate aft engine rooms.

The forward or main engine room is about 66 feet long by about 60 feet wide. The turbine compartment, however, is only 42 feet wide, while the feed pumps, feed heaters and other auxiliary machinery are arranged in two side compartments adjoining the turbines, each about 9 feet in width. The maneuvering valves and gage board are located at the forward end of this engine room, the working platform and main floor is directly over the turbines, and nothing is visible of the turbines from this working platform.

The floor does not extend over the two side compartments, and this auxiliary machinery is exposed and can be seen always by the engineers in charge. On this platform or floor, and extending down the center line of the vessel, are located the forced lubrication pumps, oil coolers and oil strainers.

The turbine steam to gland connections, oil supply pipes and valves to the turbine bearings, and turbine drain valves are all operated from manifolds arranged on this platform, and at the aft end the engine room elevator also opens on to this floor. Directly under this platform gratings are arranged, so that access to the rotor bearings and thrusts, and dummy micrometer of high-pressure ahead turbines can be reached quickly.

Floor plates are also provided above the double bottom, over the engine room bilges, so that the oil drain pipes to the drain tanks are visible. There is also plenty of clear space to allow access to the drain connections under the barrels of the turbine casings.

The wing turbine compartments extend clear across the full width of the vessel and are about 80 feet in length. No regular platform or floor is arranged in these engine rooms, but at the same level as the floor of the forward engine room gratings extend right round the outboard sides of the turbines.

Access to the turbine rotor bearings and thrusts is provided for by means of ladders. The air pumps and line shaft bearings of the inboard shafts are also reached by means of a ladder and passageway, arranged beside the entrance door to the aft engine rooms, and on the starboard side this passageway permits of access to the main dynamo compartments.

Under the regular full-speed-ahead steaming conditions the steam from all the boilers is admitted to the high-pressure ahead turbine, out of which it passes over to the mid-pressure, and from the exhaust end of this unit it is divided and passes into the two low-pressure ahead turbines, and from these to the four main condensers.

For go-astern conditions the boiler steam is admitted to each of the high-pressure astern units, from which it passes over to the low-pressure astern turbines, thence to the main condensers, that is, the port high-pressure astern exhausts to the port low-pressure astern, and the starboard high-pressure astern to the starboard low-pressure astern.

Under maneuvering conditions, such as when entering or leaving port, the two ahead turbines driving the two port shafts and the two ahead turbines of the starboard shafts are operated independently, in which case the mid-pressure turbine takes boiler steam directly.

There are four main condensers of Weir's "Uniflux" design, which have a total cooling surface of 68,700 square feet, two being placed back to back in each aft engine room, on the inboard side of the low-pressure ahead turbines. The centrifugal pumps, each pair being driven by one compound reciprocating engine, supply the cold sea water to the two condensers of each engine room. Directly under the condensers there are two single-acting air pumps of Weir's "Dual" type in each engine room, which discharge to the hot well tanks.

Eight Weir's type of "Simplex" double-acting feed pumps draw water from the hot well tanks and reserve feed water tanks and discharge to the boilers, after passing the water through surface feed heaters using auxiliary exhaust steam.

Six vertical "Duplex" forced lubrication pumps supply oil to the turbine bearings and thrusts. The two oil coolers are of the double-tube condenser type, the cooling water passing outside the outer tube and internally through the inner tube, while the heated oil passes in a film between the two tubes.

In each aft engine room is also arranged an auxiliary condenser having about 21,000 square feet of cooling surface, together with its circulating water pump and monotype air pump.

A large evaporating and distilling plant is located in a compartment on the port side, outboard of the main turbine engine room, and correspondingly on the starboard side is the refrigeration machinery.

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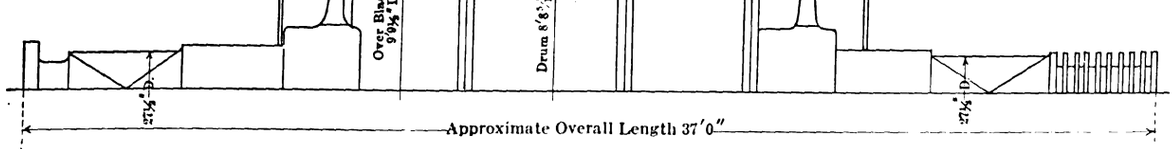
The main electric lighting plant is arranged in a space aft of the two large wing engine rooms and consists of five Brown-Boveri impulse wheel turbo-generators, each rated at 445 kilowatts and 110 volts. This compartment forms a portion of the tunnel for the two inboard lines of shafting and is about 30 feet wide and 66 feet long. An emergency electric light plant having a Diesel oil engine-driven generator is fitted well above the waterline and located close to the engineers' quarters.

The tunnel shafts are hollow, about 18⅜ inches external diameter, and the tail shafts 19⅝ inches external diameter. The two inboard lines of shafting are made up of nine lengths, which are supported by eighteen shaft bearings. The outboard lines of shafting each have three lengths, with six shaft bearings. The list, Table II, gives the leading dimensions of the various pumps.

TABLE II.—DIMENSIONS, TYPE AND SIZE OF PUMPS

Name	Type	No. Off.	Dimensions	Strokes per minute
Main air pumps	Weir, dual single steam cylinder	4	21.26" x 2 x 39.37" / 24.60"	16
Main circulating pumps	2 comp. recipg. engines combined with 4 pumps		18.50" x 31.89" / 19.68"	
Auxiliary circulating pumps	Branches about 39 inches diameter. Single cylinder engine and pump	Impeller 2	59.06 inches diameter. 8.66" / 8.66"	
Auxiliary air pump	Branches 10 inches diameter. Monotype	Impeller 41.34	inches diameter. 10.23" x 21.26" / 11.81"	40
Main feed pumps	Weir, single cylinder, double-acting vertical	8	19.68" x 13.78" / 31.50"	20
Auxiliary feed pumps	Vertical duplex double-acting	4	15.75" x 9.84" / 17.72"	34
Feed heater pumps	Weir, single cylinder, double-acting vertical	8	19.68" x 13.78" / 31.50"	20
Oil pumps	Vertical duplex, double-acting	8	11.02" x 8.68" / 12"	16.50
Bilge pumps	Vertical duplex, double-acting	4	90.55" x 10.24" / 13.78"	32
Ballast pumps	Vertical duplex, double-acting	4	11.81" x 11.81"= / 13.78"	34
Ash ejector pumps	Vertical duplex, double-acting	4	15.75" x 9.84" / 17.72"	34
Bath pumps	Vertical duplex, double-acting	2	14.17" x 11.81" / 13.78"	
Sanitary pumps	Vertical duplex, double-acting	4	14.17" x 11.81" / 13.78"	34
Drinking water pumps	Vertical single double-acting	2	9.84" x 8.66" / 9.84"	55
Evaporator pumps	Vertical duplex, double acting	2	5.98" x 5.98', / 5.90"	15
Hold pumps		4	6.97" x 6.97" / 6.97"	
Brine pumps	Vertical duplex, double-acting	4	6.69" x 6.69" / 7.87"	
Circulating pumps	In refrigerating machinery compartment at F. E. room. Motor drive centrifugal type	2	In refrigerating machinery compartment at F. E. room	

Fig. 3.—Half Section of High-Pressure Ahead Rotor. Approximate Weight, 80 Tons



DETAILS OF THE TURBINES

High-Pressure Ahead (Port Inboard Shaft).—The body of the casing is made of cast steel, built in four sections, have internal flanges and are bolted together. The two end sections of the drum have other internal flanges at the end of turned cylinders, into which are fitted the rotor end disks, and these are in turn secured by through-bolts. The overall length of the rotor drum, including dummy, is approximately 18 feet.

There are 101 rows of standard impulse-reaction blades in casing and rotor respectively, arranged in four expansion stages, with blade heights varying from 3⅛ inches to 6⅜ inches. The Parsons type of contact dummy is fitted at the steam inlet belt, and the fore-and-aft clearance between the casing and rotor is measured by the usual micrometer. Two steam pipes, each 18⅛ inches diameter, admit steam to the turbine, and the exhaust nozzle is about 42 inches diameter. The by-pass valves are fitted

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between the first and second stages, which allow for an overload of about 25 percent above the designed power.

The rotor shafts are shrunk into the hubs of each disk, and the thrust collars for the rotor adjustment are arranged at the forward end of the rotor.

High-Pressure Astern (Port Inboard).—This casing is bolted rigidly to the aft end of the high-pressure ahead. The body is made of cast iron in two half-sections and bolted together at flanges on the horizontal centerline. An impulse wheel having three rows of rotor buckets, about 12 feet mean diameter, receives the steam from the regulator valves, and this is followed by four expansion stages of the regular impulse-reaction blading on a drum construction having a diameter of 9 feet 10 inches. There are 42 rows of impulse-reaction blades in casing and rotor, with blade heights varying from 1 9/16 inches to 5 inches.

A radial fin type of dummy is fitted to the steam belt, and the overall length of the rotor drum is approximately 8 feet 6 inches.

Mid-Pressure Ahead and H. P. Astern (Starboard Inboard).—The casing of the mid-pressure turbine is built up in sections made of cast iron, and the two halves are bolted together at flanges on the horizontal centerline. The high-pressure astern turbine is bolted directly to the forward end of this unit and is similar to the high-pressure astern of the port inboard side.

The rotor has an impulse wheel with four rows of buckets about 11 feet 6 inches mean diameter at the steam inlet end, and this is followed by ten expansion stages of impulse-reaction blades on a drum construction, having a diameter of approximately 10 feet 10 inches. There are sixty rows of impulse-reaction blades in casing and rotor, the blade heights varying from 5½ inches to 13⅛ inches.

A radial fin type of dummy is fitted to the steam belt, and the overall length of the rotor drum is about 17 feet.

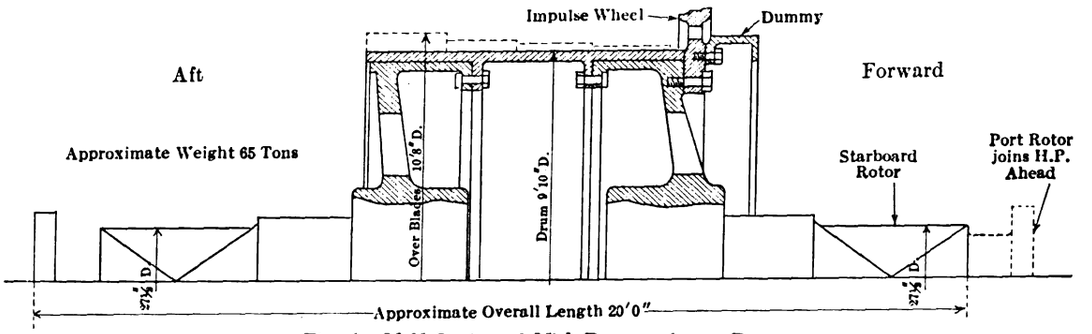

Fig. 4.—Half Section of High-Pressure Astern Rotor

When the mid-pressure ahead turbine is operating in triple series—that is, receiving exhaust steam from the high-pressure ahead—the impulse wheel is by-passed and the work done by the steam is entirely through the impulse-reaction drum blading. It is only when this turbine is being operated under "maneuvering" conditions that the impulse wheel buckets are in use, in which case the steam from the regulator valve passes into three sets of nozzles arranged in the top half casing.

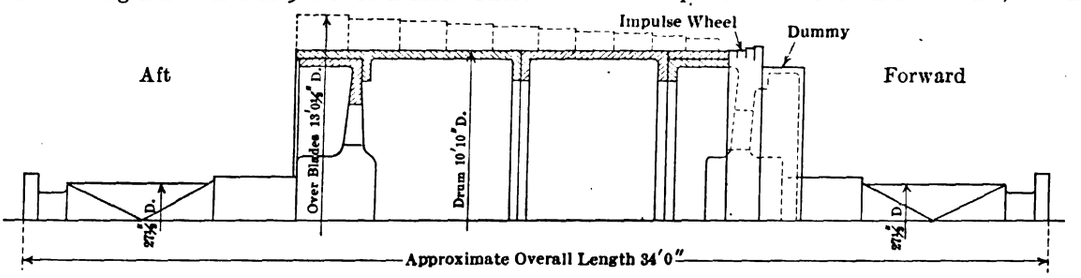

Fig. 5.—Half Section of Mid-Pressure Ahead Rotor. Approximate Weight, 100 Tons

Low-Pressure Ahead (Port and Starboard Outboard Shafts).—These casings are exceptionally large, made of cast iron and built up in a number of sections, and the two halves are bolted together at flanges on the horizontal centerline. The design of these turbines has this unusual feature—the dummy is arranged at the aft end in the main exhaust belt. Consequently, the interior of the rotor is always full of steam at the pressure of the inlet belt, and this is done possibly to overcome any tendency of the rotor to distortion under varying conditions of temperature. The dummy is of the regular radial fin type.

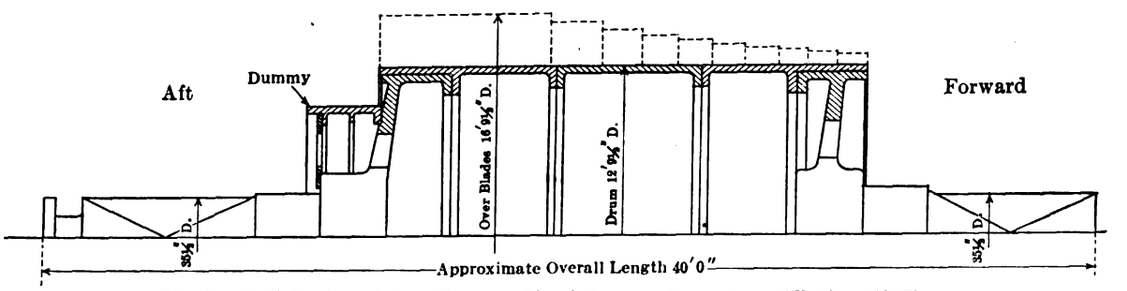

Fig. 6.—Half Section of Low-Pressure Ahead Rotor. Approximate Weight, 150 Tons

The diameter of the rotor drum is 12 feet 9½ inches,

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and it is made up of three forged steel drums bolted together at internal flanges. The end disks are also bolted to the drum with bolts. The overall length of the rotor drum and dummy is approximately 21 feet 3 inches.

There are sixty-three rows of impulse-reaction blades in casing and rotor, arranged in twelve expansion stages, the blade heights varying from 5¼ up to 24 inches. The internal diameter of the casing at the exhaust barrel is 16 feet 9½ inches.

Low-Pressure Astern (Port and Starboard Outboard Shafts).—These casings are bolted rigidly to the aft end of the low-pressure ahead. The body is made of cast iron built up in four sections, a vertical joint being arranged about the middle of the barrel, the pedestals which support the bearings, etc., being bolted to the casing and arranged so that they can slide in the aft direction. The diameter of the rotor drum is about 10 feet 10 inches and it is made up in two sections bolted together. The disk ends are bolted to internal flanges arranged at each end of the drum. The dummy at the steam inlet belt is of the radial fin type and the overall length of the drum is about 11 feet.

There are thirty-seven rows of impulse-reaction blades in casing and rotor, arranged in five expansion stages, with blade heights varying from 6 3/16 inches to 13⅜ inches in length.

Impulse-Reaction Blading.—The standard Parsons' blade sections are used throughout, the material being a common brass mixture, the groove widths varying from ½ inch to 1½ inches, the width of the blade section being dependent on the length of the blade. The usual method of fitting separate packing sections between each blade is adopted. About the center of the forward edge of each groove in casing and rotor a semicircular projection is left, and each blade and packing section is correspondingly notched out so as to fit over the projection. By this method each blade and packing section is held mechanically. The binding strips are of round brass wire, which is fitted in a hole drilled through the blades, and the wire is then silver soldered to each blade. In the long blades there are three rows of binding wires. The ends of all the blades are thin-tipped, in accordance with Parsons' usual practice.

Impulse-Wheel Buckets.—The composition buckets of the impulse wheels are fitted similarly to those of the reaction blading, that is, the buckets and the packing sections are separate. The method of holding them in the rotor grooves is, however, slightly different. The rectangular grooves of the rotor have semicircular projections on each side, and the buckets and sections are notched out to fit over these projections. To allow for fitting, at one place on the rotor rim the notches are cut out and the buckets and sections entered at this point and driven round. The tips of all the rotor buckets are thinned and no shroud strip is fitted, which is somewhat unusual.

In the case of the high-pressure astern impulse-wheel buckets, the first and second rows are entirely unsupported, but the third row has a round wire threaded through each bucket and silver soldered; the widths of the buckets are about 1 inch, the lengths varying from 2⅛ inches to 3½ inches.

The mid-pressure rotor has four rows of buckets on the impulse wheel; the first row is entirely unsupported, the second and third rows have one round wire threaded through each bucket, and the last row has two round binding wires. The lengths of the buckets vary from 4 inches to 7½ inches and are about 1 3/16 inches in width.

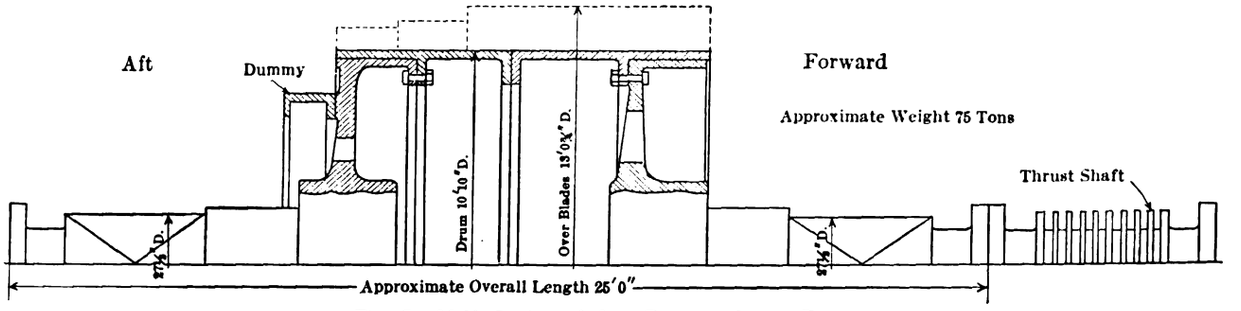

Fig. 7.—Half Section of Low-Pressure Astern Rotor

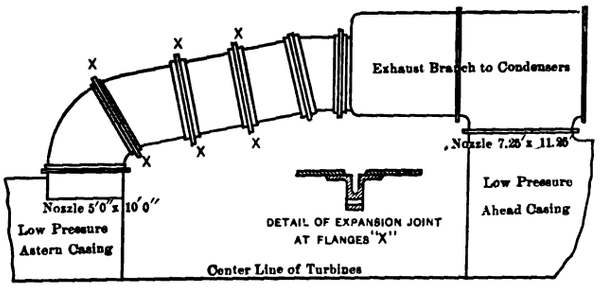
Exhaust Branch to Condensers
Nozzle 7.25"x 11.25"
Low Pressure Ahead Casing
Nozzle 5'0"x 10'0"
Low Pressure Astern Casing
DETAIL OF EXPANSION JOINT AT FLANGES "X"
Center Line of Turbines

Fig. 8.—Side Elevation of Exhaust Arch Between Low-Pressure Astern and Nozzle to Condenser

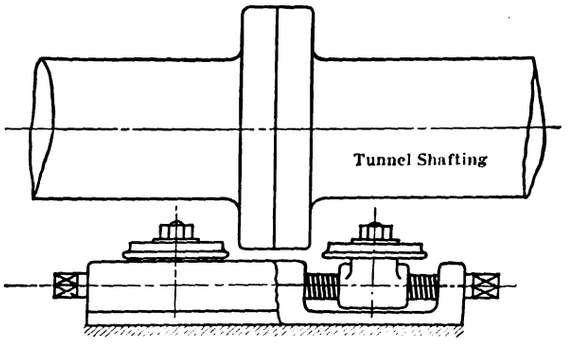

Fig. 9.—Sketch of Screw Roller Gear for Adjustment of Rotors

The Maneuvering Gear

The entire maneuvering of the turbine engines is carried out from the working platform of the forward engine room, the regulator valves being all arranged at the forward bulkhead.

Four lines of steam pipes pass the steam from the boilers over to the engine room—two on the port side and two on the starboard side. The stop valves connecting with these steam lines are in the engine room, and they are operated hydraulically. A cross-connection pipe runs

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between the port and starboard valves. From each of these valves the steam passes into a steam strainer chest combined with an automatic trip valve, which has connections to the five main regulator valves of the turbines.

Interconnecting Pipes and Change Valves Between the Turbines.—The different ways in which the turbines can be operated and the means taken to do this have features of interest. Dealing with the high-pressure ahead, this unit can be operated in three different ways:

1. The exhaust steam can pass over to the mid-pressure turbine, as in "triple-series" connection.
2. It can exhaust directly to the port low-pressure ahead, as under "Maneuvering."
3. The exhaust steam can pass directly to the condensers of the port side.

The mid-pressure ahead turbine can be worked as follows:

1. Triple-series, receiving exhaust steam from the high-pressure ahead.
2. Maneuvering, live steam is admitted to the nozzles of the impulse wheel, passes through the reaction blades and over to starboard low-pressure ahead.
3. The exhaust steam can pass directly to the condensers of both port and starboard sets through the change valves on port and starboard side.

The high-pressure astern turbines of the inboard shafts can be used as follows:

The exhaust steam from each of these units can pass over to the low-pressure astern, or, for emergency conditions, change valves are installed, so that they can exhaust direct to the condensers. The exhaust pipe connections between the astern units are exceptionally long and about 29 inches in diameter. They are arranged on the lower half of the casings, and on the starboard side the length of this pipe is about 130 feet, and on the port side about 100 feet.

Main Turbine Repairs and Overhaul

At the time the vessel was taken over, the high-pressure ahead turbine casing was open. The rotor had also been lifted, and on examining the blading, dummy, glands and bearings it was soon seen that this engine was in perfect condition, and in a short time the rotor was lowered and the casing closed up for good.

The manhole on the aft end of the mid-pressure was opened up and a preliminary examination appeared to indicate that this engine was also in good working order.

The rows of impulse wheel buckets were exposed by opening a manhole on the upper half casing. Manholes arranged at each end of the low-pressure ahead turbines allowed me thoroughly to examine the end rows of blading, and this was all found to be in good order.

The safest course to follow as regards finding out the internal conditions of these three ahead turbines was to turn them with the turning gear in both ahead and astern direction and listen carefully for unseemly noises. Steps were taken to do this, but it was found that the cast-iron

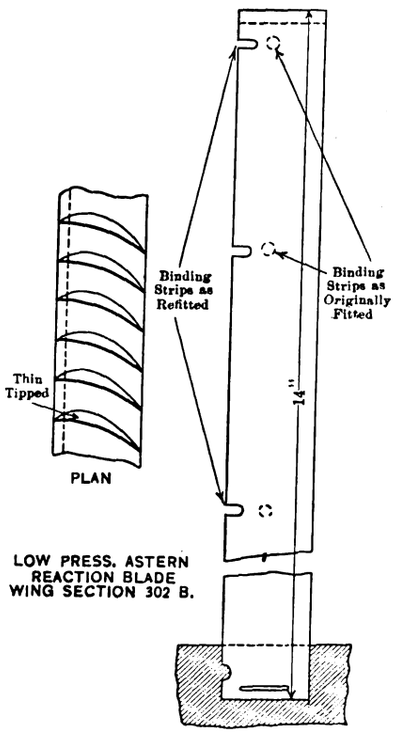

Fig. 10

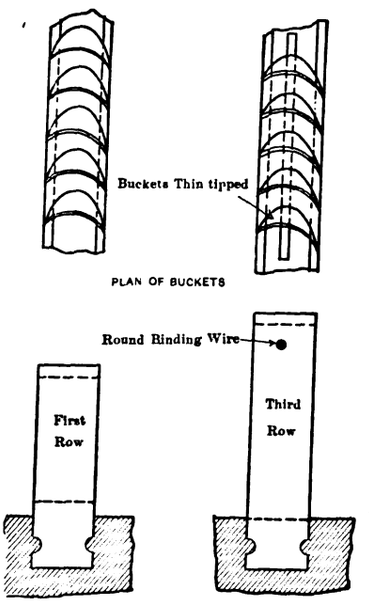

Fig. 11.—High-Pressure Astern Impulse Buckets

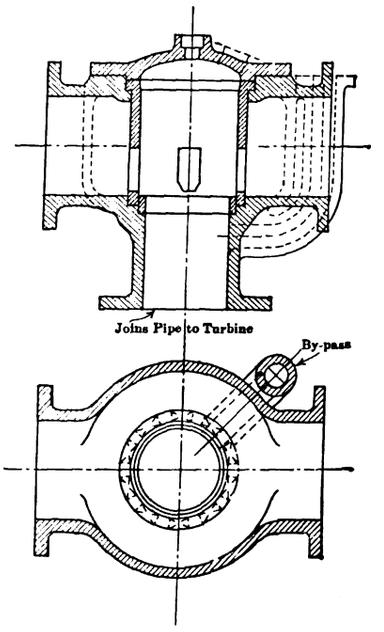

Fig. 12.—Sketch of Turbine Regulator Valve

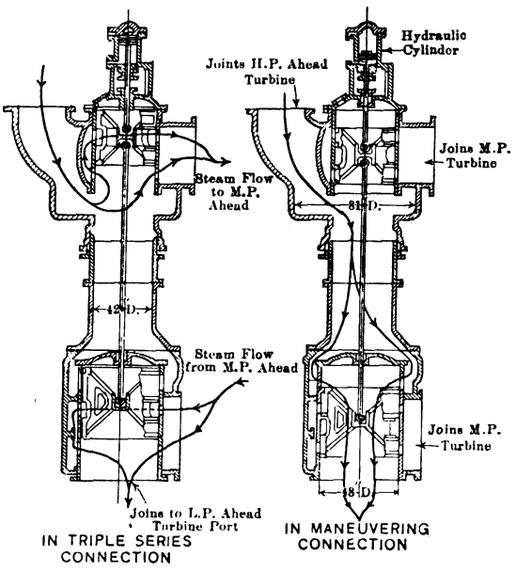

Fig. 13.—Mid-Pressure Turbine Change Valve

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brackets which support the various parts of the turning gear were badly fractured. Repairs were put in hand at once, and on July 10 the mid-pressure rotor was revolved in the ahead and astern directions and found to be in splendid working order.

The preliminary examination of the four astern turbines showed that a considerable amount of damage had occurred in the blading. Both high-pressure asterns showed damaged blading at the exhaust end rows, and in addition a pocket about 18 inches wide had been cut through ten

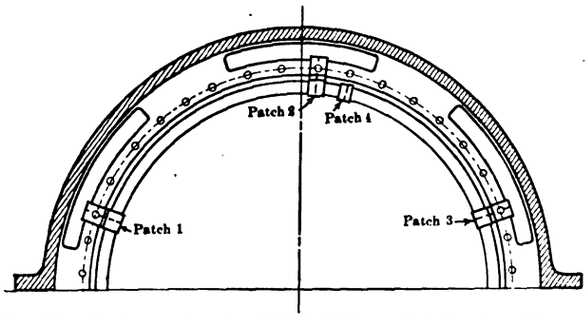

Fig. 14.—Section at Impulse Wheel Exhaust Belt Looking Forward

rows of rotor blades and ten rows of the casing blades on the port turbine, and six pairs of rows on the starboard. The condition of the blading at the steam inlet end could not be seen until the upper half casing was lifted.

Both low-pressure asterns also showed that there was damaged blading at the steam inlet end and also at the exhaust end, and, in addition, pockets about 15 inches wide had been cut through nine pairs of rows of blading in one case and seven in the other.

High-Pressure Astern (Port Inboard Shaft).—Upon

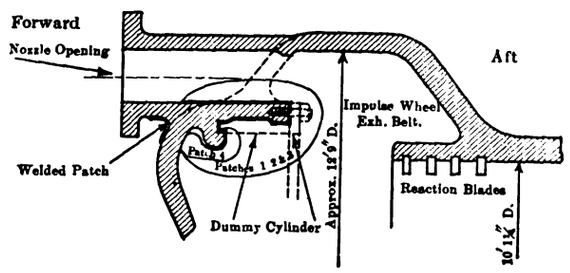

Fig. 15.—Approximate Section Through Nozzle Openings Showing Detail of Electric Weld Patches. Starboard H. P. Astern Cylinder Top Half

lifting the top casing and rotor, the following conditions were noted:

(*a*) The three rows of impulse wheel buckets of rotor were badly damaged and required to be entirely renewed.

(*b*) The cast-iron dummy cylinder had been removed, and this was found lying around badly fractured.

(*c*) The dummy piston of the rotor was seriously distorted, and pieces of the dummy cylinder and the brass fin strips had fused in lumps onto the surface of the piston.

(*d*) The four last rows of the rotor blades and three rows of top and bottom casings, together with the blading cut out in the pocket, all required renewal.

The following repairs were made.

A new cast-iron dummy cylinder was fitted. This was made in six pieces, three for the lower half and three for the upper.

Attempts were made to chip, file and grind the dummy piston of the rotor, but this was not satisfactory, and eventually this was machined and new dummy fin strips fitted. To machine the dummy piston, the rotor was lowered into place and connected up with the turning gear, a cut was taken across the surface and the grooves for the fin strip were turned out.

All the damaged blading at the exhaust end of rotor and casing was renewed, the total number of new blades being approximately 6,500.

After careful consideration it was deemed advisable not to refit the impulse wheel buckets, inasmuch as the indications tended to show that the blading troubles were caused by distortion of the impulse wheel under steaming condi-

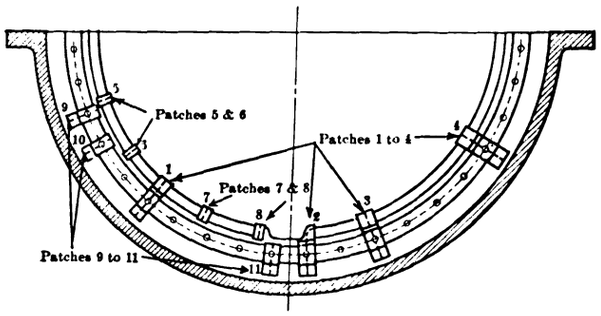

Fig. 16.—Section at Impulse Wheel Exhaust Belt Looking Forward

tions. Therefore the three rows of buckets in the rotor wheel were removed, together with the two segments of casing guide vanes, as well as the nozzles in the cast-steel chambers.

This turbine was opened up early in June and closed up on October 11, 1917.

Low-Pressure Astern (Port Outboard).—When this turbine was opened up the following blading repairs were found necessary:

Rotor.—(*a*) The first four rows and part of the fifth

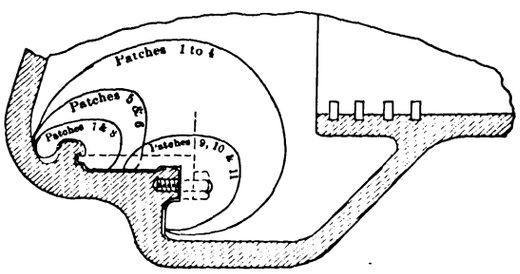

Fig. 17.—Approximate Section Across Impulse Wheel Exhaust Belt, Showing Detail of Electric Weld Patches. Starboard H. P. Astern Cylinder, Bottom Half

row at the steam inlet end were damaged. (*b*) First row of second expansion stage. (*c*) The last two rows at the exhaust end, together with a pocket 15 inches wide cut through nine rows of blades.

Lower half casing.—The first four rows of the steam inlet end and the first row of second expansion all badly damaged.

Top casing.—The first four rows at the steam inlet end, the first row at the second expansion, and part of the last two rows at the exhaust end were damaged. In addition to this, a pocket 15 inches wide was cut through eight rows of blades.

All this blading was refitted completely, amounting in all to about 13,500 blades and packing sections, and the turbine was closed up on September 25.

On October 7 this turbine was coupled up to the low-pressure ahead and both revolved by the turning gear in ahead and astern direction, and everything was found to be in order.

Low-Pressure Astern (Starboard Outboard): Rotor.—

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(*a*) The first four rows at the steam inlet end and the last row at the exhaust end were badly damaged. (*b*) A pocket about 16 inches wide had been cut through the last seven rows of blades at the exhaust end.

Lower half casing.—The first four rows at the steam inlet end were badly damaged.

Top casing.—(*a*) The first three rows at the steam inlet end and last row at exhaust end were badly damaged. (*b*) A pocket about 16 inches wide had been cut through seven rows of blades.

All this blading was refitted, amounting to about 10,000 blades and packing sections.

This turbine was closed up on October 4, and on October 20 it had been coupled up to the low-pressure ahead and both revolved in ahead and astern directions satisfactorily.

High-Pressure Astern (Starboard Inboard).—When this casing was opened it was seen that very considerable repairs would be necessary to make this turbine work successfully:

(*a*) The three rows of the impulse wheel buckets of rotor were badly damaged.

(*b*) The dummy cylinder had been removed and the dummy piston showed clearly that it had been rubbing in contact with the dummy cylinder. Lumps of metal had fused onto the piston surface and it was badly distorted.

(*c*) The four last rows of rotor and casing blades were damaged and required renewal, together with a pocket 18 inches wide, which had been cut through six rows of rotor blades and six rows of casing blades in the lower half.

(*d*) The cast-iron casing was also found to have large cracks or fractures, which had undoubtedly been caused by the revolving dummy piston of rotor coming in contact with the dummy cylinder, which eventually fractured into a number of pieces. These pieces apparently jammed while the rotor was revolving, and finally resulted in fractures developing in the main casing walls.

Top casing.—(*a*) On the interior surfaces there were four fractures in all, three being in the nozzle openings. Fig. 14 shows the approximate position of the damage in the casing, and also the extent of the fractures.

(*b*) Externally, there were small cracks under the nozzle openings, in line with the internal fractures.

Lower casing.—In this half of the casing the damage was much greater and the question of making satisfactory repairs became a very serious matter.

(*a*) There were eleven internal fractures or cracks (see Figs. 16 and 17).

(*b*) Fractures 1 to 4 are somewhat similar to the three in the upper half; they extend from the facing to which the dummy cylinder is bolted right over to the dished end wall of the casing.

(*c*) Fractures 5 to 8 occurred in the wall which supports the end of the dummy cylinder and are similar to fracture 4 of the upper half casing.

(*d*) Fractures 9 to 11 are across the facing to which the dummy cylinder is bolted.

Around the external wall of the lower half casing eight bulb webs are arranged at equal distances and support the dished end of the casting. Seven of these were fractured completely through, and the damage extended into the main body of the cylinder wall.

The engineers had attempted to limit the extent of the fractures, for brass pegs had been fitted at the end of some of the cracks.

A drain facing on bottom of the turbine was also cracked at the base for about one-half of the circumference, and pegs had been fitted to each end of this fracture.

A small cofferdam was built up in the casing at the steam belt and filled up with water, but the water began to pour through to the outside, showing that the fractures extended through the full thickness of the casing wall, which is about 3½ inches thick.

Upon reporting the conditions to Capt. Earl P. Jessop, U. S. N., engineer officer at the New York Navy Yard, who was in charge of all the repairs in these ships, Mr. Jessop made a thorough examination of the casing and strongly advised electric welding the fractures. Mechanically fitted patches could not be fitted internally, because

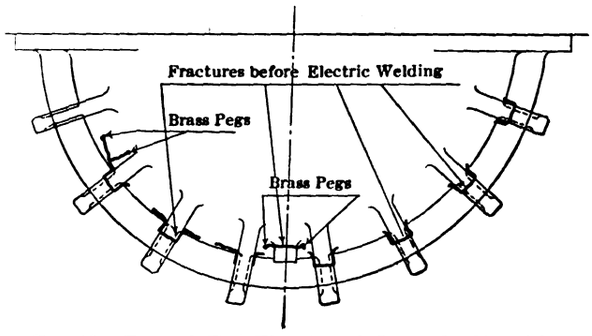

Fig. 18.—External End Elevation of Casing Looking Aft

the damage was all located in the casing where it supports the dummy cylinder. Mr. Wilson, of The Wilson Welder and Metals Company, also reported most favorably as regards bringing this work to a successful completion, and about the middle of July work was commenced on preparing the fractures for welding. This was carried out as follows:

Along the line of fracture a V-groove was chipped out. On either side of this groove ¾-inch diameter holes were drilled and tapped, into which were fitted steel studs, the

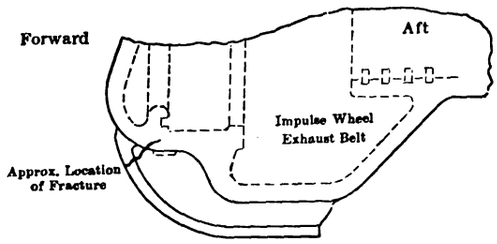

Fig. 19.—Approximate Side Elevation Showing Bulb Webs. Starboard H. P. Astern Cylinder, Lower Half

end of each projecting above the metal about ¼ inch to ⅜ inch. In most cases two rows of studs were fitted and staggered, the pitch being about 2¼ inches.

The welding material used was a steel alloy wire, about 3/16-inch diameter. The first layer was placed along the length of the fracture at the bottom of the V-groove. This layer was then peaned down; if found to be loose, it was cut out and the work begun over again. On top of this another layer was welded in and again peaned down, and this process was repeated until the weld was built clear round the studs and projected about ¼ inch above the surface of the adjoining cast iron.

After this work was completed the casing was tested under water pressure to about 100 pounds per square inch and found to be practically watertight. Before the new dummy cylinder could be fitted it was necessary to grind down the weld patches until they projected only about ⅛ inch above the faces of the adjoining wall, and the dummy cylinder castings were notched out to fit over the patches.

All the damaged reaction blades were replaced; this

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amounted to about 8,000 new blades and packing sections, and the turbine was closed up on October 31.

Boilers

The boilers are arranged in four watertight compartments, three compartments having four groups with three boilers per row athwartships, while the forward compartment contains ten boilers, making a total of forty-six boilers in all. Coal bunkers are arranged in the wings at the sides of the boilers, separated by watertight compartments.

The boilers are of the Yarrow type, having one steam drum connecting through two groups of tubes to the lower drums, each boiler having three furnaces. The working pressure is 235 pounds per square inch gage, and the heating surface of the generating tubes is approximately 210,000 square feet. They are designed to work with Howden's forced draft, four large breast fans driven by compound reciprocating engines supplying the air.

The boilers were found to be in fair condition, and only two required to be re-tubed. The brickwork was renewed in a large number, and it was also found necessary to install new fire bars, so as to allow more air to pass through the fires.

General Overhaul

While the repairs to the main turbines were in progress, the auxiliary machinery was overhauled thoroughly: the four main condensers were water-tested, new tubes fitted to the auxiliary condensers, and new packing was fitted to the gland bushes of all reciprocating engines and steam cylinders of the auxiliaries. The main steam lines, as well as the auxiliary steam lines, were fitted with proper drains and traps. The forced lubrication system, including oil coolers, oil drain tanks and piping, was thoroughly cleaned. The line shaft bearings were removed and freed of all grit and dirt and the stern tube glands repacked.

Dock Trials

The preliminary steam trials of the turbines began early in November and were made with the turbines uncoupled from the line shafting. All the turbines were driven up to full-speed revolutions, namely, 180 per minute.

A slight hitch occurred with the starboard high-pressure astern. The regulator valve jammed open, resulting in the turbine gaining momentum rapidly. On shutting the by-pass valve the steam pressure on top of the piston forced this down with a bang, and on opening out the valve it was found that the piston valve was fractured right around the metal which supports the valve stem. It is useless to speculate just when this fracture took place, but it is not improbable that it may explain why this turbine was damaged much more than the other units.

Sea Trials

The vessel left New York Harbor for extended trials on November 17 and returned on November 20. During that time various trials were carried out at cruising speeds and records of the coal consumed were made.

A short trial was made at full speed, the average revolutions of the four shafts being 171 per minute, corresponding to a speed of about 22.50 knots. No torsion meters were in use, but the estimated shaft horsepower amounted to about 65,000.

The main turbines worked splendidly throughout the whole series of the trials, and absolutely no adjustments had to be made. The engines maneuvered splendidly and the astern turbines did good work. Minor adjustments were made to some of the auxiliary machinery and to the steering gear, but, taking everything into account, the performance of the machinery was most satisfactory.

Buoyancy and Stability of Troop Transports*

Requirements for Safety of Troop Ships—Changes in Subdivision of Existing Vessels and Spacing of Bulkheads in New Designs

BY PROFESSOR WILLIAM HOVGAARD

As the number of troops on board a transport often greatly exceeds the number of passengers carried on a liner of the same size, this fact, in connection with the urgency and vital character of military expeditions in general, makes the problem of the safety of troop transports rank higher in importance than in the case of ordinary passenger steamers.

Requirements for Safety

In order to obtain a basis for the discussion, it is necessary to make certain assumptions as to the amount of damage which it may reasonably be stipulated that troop transports should be able to stand without their safety being imperilled. In addition to the ordinary dangers of navigation, notably collision and grounding, such vessels are in time of war exposed to attack from artillery, mines and torpedoes, but we consider here those dangers only in so far as they affect the buoyancy and stability, involving damage below the bulkhead deck. In this connection underwater explosions are the most important.

Evidently the minimum claim to buoyancy and stability of a troop transport is that they should stand the effect of one underwater explosion or one collision without sinking or capsizing. But this is not sufficient. In order to provide for roughness of the sea and allow the safe lowering of the boats, there must remain a certain margin of reserve buoyancy and the ship must not take a great list. Since an explosion or a collision is liable to damage one of the main transverse bulkheads, those requirements must be satisfied even if two adjoining compartments are flooded, whatever the conditions of loading. Finally, the spacing of the bulkheads should be such that there will be very little chance of two bulkheads being damaged by one explosion.

As explained hereafter, the claims stipulated above practically determine a minimum length of troop transports. It is at once clear, moreover, that in order to prevent a ship from taking an excessive list in the damaged condition, she must be subdivided essentially on the transverse system, and the metacentric height must not fall below a certain minimum dependent on the size and design of the ship and the condition of loading.

* Paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1919.

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Under this head we discuss the spacing of the transverse main bulkheads with special regard to the danger of foundering by bodily sinkage, eventually combined with longitudinal inclinations, which may cause the ship to go down by the bow or the stern. We disregard the presence of longitudinal bulkheads and the transverse inclinations which they may produce.

BUOYANCY

In case of ships for which all the design data, as well as the condition of loading, are accurately and completely known, the problem is relatively simple. The effects of bilging on draft and trim can be calculated by direct methods, all combinations of flooding of two or more compartments in accordance with the stipulated requirements being studied. There is, in fact, nothing in the problem which calls for an explantion beyond that already given in text-books on naval architecture. The difficulties arise when it is required on short notice to equip and use ships for transport service, such as ordinary trans-oceanic steamers, about which only incomplete information is at hand and where circumstances do not allow time or opportunity for complete calculations. Such were the conditions in case of many passenger steamers taken over in 1917 by the United States Navy for use as troop transports, especially the German vessels, for which in general no line drawings, general arrangement plans, or weight statements were available. In all such cases it is necessary to resort to approximate methods of investigation.

Specific problems as to the effect of flooding of certain compartments may be solved directly by rough calculations, using approximate methods. In the *Leviathan,* for instance, it was found that flooding of all four engine rooms, together with adjacent side compartments, would produce a bodily sinkage of about 4 feet and a total change of trim by the stern of 14½ feet. In the *Mount Vernon* a similar state of bilging would produce a sinkage of 3¾ feet and a total change of trim by the stern of 11¼ feet. This mode of investigation, however, cannot be applied with advantage to all possible cases of flooding of one or more compartments in a ship, because it would involve an amount of labor that would hardly be warranted, in view of the crudeness of the available data as here assumed. A more general and simple method is needed when it is required to deal with a great number of ships in a short time, in which case broad, comparative results are of more interest than absolute quantitative values.

We shall here briefly describe the so-called "floodable-length" method devised by the Committee on Subdivision of Merchant Ships, appointed by the British Board of Trade.* This method enables a designer with relatively small work to study the spacing of the bulkheads in a new ship with a view to the fulfillment of given requirements as to subdivision, and provides a ready means of determining the status in this respect of an existing ship, giving a measure of its safety as well as suggestions for eventual alterations in the watertight subdivision.

THE FLOODABLE-LENGTH METHOD

In principle the method consists in determining the "floodable length" at any point in a ship, being the length of hold, having its center at that point, which can be flooded without the ship foundering. The spacing of the bulkheads is expressed as a fraction of the floodable length obtained by multiplying it with a "factor of subdivision." If that factor is everywhere equal to or smaller than unity, but still greater than one-half, any one, but not any two, compartments may be flooded without the ship going down, and we have what is commonly called a "one-compartment" ship. If the factor is everywhere equal to or smaller than one-half, but still greater than one-third, any two, but not any three, adjoining compartments may be flooded without the ship going down, and we have a "two-compartment" ship, and so forth.

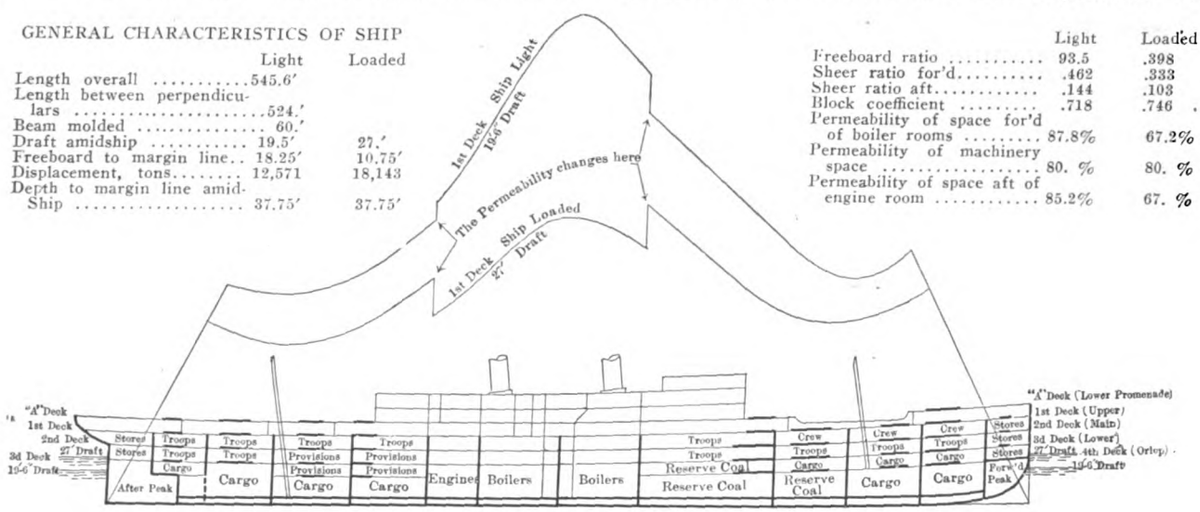

Fig. 1.—Curves of Floodable Length

The floodable length is found as described in Vol. I of the Report of the Committee, while Vol. II gives a number of diagrams from which it may be obtained directly, expressed as a percentage of the length of the ship. The so-called "margin-line" forms the basis of the calculation. It is drawn 3 inches below the deck-at-side line of the bulkhead deck, the latter being defined as the uppermost continuous deck to which all transverse watertight bulkheads are carried. The floodable length is so determined that when that length of the hold is flooded the ship shall not be submerged beyond the margin line.

Various elements are used as arguments in the diagrams of Vol. II for finding the floodable length, the most important being the freeboard ratio, which is the ratio between the freeboard to the margin line amidships and the draft amidships. Greater freeboard at the ends is taken into account by the sheer ratio, which is the ratio of the sheer of the margin line at the forward or after

* The provisions of the International Convention for the Safety of Life at Sea relating to Safety of Construction of Ships are in substantial agreement with the results of the investigations of this committee, which made its report in November, 1914.

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end to the draft amidships, the sheer being measured from the horizontal line through the lowest point of the margin line. The element next in importance is the permeability, which is the percentage of a given space that can be occupied by water. When a ship is in the light condition, the high permeability of the empty hold spaces to some extent neutralizes the favorable effect of the greater freeboard, but nevertheless the floodable length is ordinarily much greater than in the full-load condition. Exceptionally the floodable length in the light condition may fall below that in the full-load condition at the ends. The numerical value of the permeability should be calculated very carefully, as it exerts a great influence on the result. The diagrams in Vol. II of the Report are prepared for permeabilities of 60 and 100 percent. The floodable length for other permeabilities must be obtained by interpolation. The form of the hull is taken into account by using the block coefficient as one of the arguments in the diagrams, which are calculated for a standard form of various degrees of fineness. If ships differ materially from the standard form, certain corrections must be applied.

When the floodable length is obtained for a number of stations in a given ship or design, the results are marked up as ordinates from the base line of a profile drawing, which shows the location of the bulkheads, and a "floodable-length curve" is drawn through the points so obtained, giving, together with the bulkheads, a graphical representation of the safety of the ship in damaged condition.

In Fig. 1 such curves are given for one of the ex-German ships used as a troop transport during the war. The lower curve corresponds to the full load, the upper to the light condition.

All floodable-length curves are characterized by a maximum amidships, a minimum on about one-quarter of the length from each end, and a pronounced rise towards the ends of the ship.

The floodable-length method, being applicable to all sizes and types of vessels, cannot, of course, be expected to give accurate results in any specific case. Nor is this claimed for it; but, used intelligently, it affords a valuable means of dealing in a practical and comparatively simple manner with problems relating to the spacing of bulkheads. It enables the naval architect to judge whether a given ship is suitable for use as a troop transport and to determine what alterations, if any, should be made in it to improve the safety. It was applied to all vessels used as transatlantic troop transports by the United States Navy during the war, and showed that all the ex-German ships when in the light condition were two-compartment ships, many of them with an ample margin, and some approached or reached the three-compartment standard. In the full-load condition most of those vessels came up to the two-compartment standard.

Changes in the Subdivision of Existing Ships

In cases of emergency, ships may have to be used which are far from satisfactory in point of subdivision, but it must be borne in mind that other qualities have also to be considered. High speed and good maneuvering capability, which materially reduce the dangers of attack by submarines, may outweigh defects in subdivision. A well-subdivided but slow vessel may be more exposed to destruction by submarines than a poorly subdivided but faster vessel. Also the accommodations immediately available in a ship for carrying troops have to be considered.

If the subdivision of an existing ship is found unsatisfactory, conditions may be often materially improved by carrying one or more bulkheads up to the deck next above the bulkhead deck. This applies in particular to ships where non-watertight bulkheads, which can be readily made watertight, exist above the bulkhead deck as extension of some of the main bulkheads. The addition of one or a small number of new watertight bulkheads and slight modifications of bulkheads already existing above the bulkhead deck will be then sufficient to raise the bulkhead deck for the whole or part of the length of the ship, and the safety may be thus immensely increased. In some cases the subdivision below the bulkhead deck may with advantage be supplemented by additional bulkheads. Alterations of this nature were made by the Bureau of Construction and Repair in a number of transports, but, on account of the urgency of the service and the short stay in port of the vessels, no extensive changes could be carried out.

Spacing of Bulkheads in New Design

The claim stipulated above that a troop transport should be able to stand the effect of one underwater explosion determines the two-compartment standard as the minimum requirement, but where the size of a ship allows a higher standard to be reached the designer should, of course, take advantage of this fact, even when that standard cannot be maintained throughout the entire length of the ship.

In determining the spacing, the designer must take into account the probable extent of the damage, the probability of bulkheads being lost, and the effects on the buoyancy. He must consider also the limitations imposed by the size and length of the ship, as well as by the general requirements of the service. We shall take up each of these questions separately.

(*a*) The first thing to consider is the horizontal extent of the zone of rupture and deformation caused by the explosion of a mine or torpedo, in so far as those effects destroy the integrity of the bulkhead. Its value varies greatly with the size of the charge and with various other conditions, but seems to lie between 25 and 55 feet. We shall denote this quantity by e and assume that under present conditions its probable highest average value is 35 feet. This is but slightly smaller than the figure adopted by Mr. W. S. Abell, chief ship surveyor of Lloyd's Register of Shipping, in a paper read before the Royal Society, January 22, 1919, discussing the same subject for cargo vessels.

(*b*) There is for every part of a ship a lower limit to the spacing of the bulkheads, determined with regard to proper housing and working of the machinery, the service of the ship, the accommodation of the troops, and the stowage and handling of cargo, as well as the proper utilization of space in general. In the forward and after holds, excepting the extreme end compartments, the spacing seldom falls below 35 feet in practice, and probably 40 feet may be considered as the smallest desirable spacing of the bulkheads in those parts of the ship. In the midship portion, where the machinery is located, it is often necessary to make the compartments much larger, especially in ships like troop transports which have or should have great engine power.

(*c*) If the spacing of the bulkheads is equal to e, the extent of the damage caused by an explosion, it is likely that an attack would always injure at least one bulkhead, but by increasing the spacing beyond this limit even by a very moderate amount, the probability of a bulkhead being lost is very much reduced. Let the spacing be s, then this probability, which we shall call c, is measured by the ratio between the danger space, e, and the remaining

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space, $s - e$, in each compartment. Hence,

$$c = \frac{e}{s - e}. \qquad (1)$$

When $s = e$, we have $c = \infty$, but when s is 20 percent greater than e, $c = 5$, that is, the chances are only 5 to 1 that a bulkhead will be lost by a single explosion.

Based on these considerations, it is proposed in troop transports to adopt a minimum spacing of the bulkheads $S_0 = 45$ feet, which gives a maximum value of the probability factor:

$$c_0 = \frac{35}{45 - 35} = 3.5.$$

(*d*) In order to secure the two-compartment standard, the combined length of any two adjacent compartments must in no case exceed the floodable length, f, and should in general be slightly smaller. Hence,

$$2S \lessdot f, \qquad (2)$$

and the smallest permissible floodable length will be

$$f_0 = 2S_0, \text{ or} \gtrdot$$
$$f_0 = 90 \text{ feet}. \qquad (3)$$

When the floodable length at any point is so great as to admit of a subdivision into three compartments, each of which has a length greater than S_0, the three-compartment standard should be adopted in that region if practicable. In such a case no single explosion is likely to flood a greater length than $\frac{2}{3}f$, and a margin of safety will remain, which enables the ship to sustain further damage without sinking. A similar procedure may be followed where practicable in cases where $f > 4S_0$, resulting in a still greated margin of safety.

(*e*) If we take into account not only the direct effects of flooding, but the probability of a bulkhead being lost, there is a limit to the closeness of spacing of bulkheads, which it is not profitable to pass. In other words, contrary to what might appear at first sight, it is not always advantageous from the point of view of safety to space the bulkheads closer together.

Consider first a one-compartment ship, where the loss of a bulkhead means the loss of the ship. If the spacing is here made equal to e, there is a practical certainty that the ship will go down if she is hit by a torpedo. If the spacing is 45 feet—that is, $S = S_0$—we have seen that the probability of a bulkhead being lost is as 3.5 to 1. Suppose now that the floodable length is 90 feet, the limiting value for the one-compartment standard, then by making $S = 90$ feet the probability of a bulkhead, and hence of the ship, being lost is reduced to

$$c = \frac{35}{90 - 35} = 0.64.$$

In general, the greatest safety within the one-compartment standard—that is, for $f = 2S_0$, is evidently attained

$$\lessdot$$

by making the spacing equal to or slightly smaller than the floodable length.

Suppose, next, that a ship is designed to the two-compartment standard and that, consequently,

$$2S_0 < f < 3S_0,$$

or, with the value of S_0 here adopted,

$$90 \text{ feet} < f < 135 \text{ feet}.$$

With a spacing of $S = S_0 = 45$ feet, we have again the probability of a bulkhead being lost: $-c = 3.5$; but gradually, as S is increased, c will fall off, until in the limit when f is equal to 135 feet and S equal to, say, 65 feet, we have

$$c = \frac{35}{65 - 35} = 1.17,$$

that is, the chance of a bulkhead being lost is one-third of what it would be with $S = 45$ feet. This advantage of the wider spacing is believed to outweigh the drawback that when a bulkhead is lost and two compartments flooded there will be a smaller margin of safety than with the shorter spacing. Hence it is best in a two-compartment ship always to make the spacing approach one-half of the floodable length.

When $f > 3S_0$, or $f > 135$ feet, the three-compartment standard can be attained. Suppose that

$$135 \text{ feet} < f < 180 \text{ feet},$$

then the best result is attained within the three-compartment standard by making S equal to or closely approaching $\frac{f}{3}$, in which case the probability of a bulkhead being lost will range from 3.5 to 1.4. It might be argued that it would be better to retain the two-compartment standard and make $S = \frac{f}{2}$, since then the value of c would be much reduced and would range from 1.08 to 0.64, but in that case the hold compartments would be unnecessarily, perhaps inconveniently, large, and when a bulkhead was lost the flooded length would be 50 percent greater than with the three-compartment ship. It is to be borne in mind also that a three-compartment ship is better able to stand underwater damage caused by collision or gunfire, which is not so liable to destroy the bulkheads. Hence, when f is greater than $3S_0$ and smaller than $4S_0$, the three-compartment standard should be adopted with S equal to or slightly smaller than $\frac{f}{3}$.

It is clear that the same reasoning will apply and an analogous conclusion will be reached when the floodable length is greater than $4S_0$ and we arrive at the following general rules:

1. The standard of subdivision should be the highest consistent with the floodable length and with the adopted minimum spacing of the bulkheads. If $nS_0 < f < (n + 1)\ S_0$, the n-compartment standard should be adopted.

2. Within the given standard of subdivision, the spacing of the bulkheads should be the greatest possible consistent with that standard, provided no practical considerations stand in the way of such spacing. With the n-compartment standard the spacing should closely approach $\frac{f}{n}$. In other words, the factor of subdivision according to this rule is practically either unity or some simple fraction: ½, ⅓, ¼, etc. It should be observed that the same ship may be subdivided to different standards, depending on the value of the floodable length at various points. Frequently ships which may be subdivided to the three-compartment standard at amidships and at the extreme ends can be subdivided only to the two compartment standard on the quarter length, where the floodable length is a minimum, and such vessels will be referred to as two-compartment ships.

(*f*) In troop transports which are liable to be loaded more deeply than ordinary passenger vessels, the floodable

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lengths are relatively small. In the following table are given the average minimum values of f as found in troop transports of good design used during the war by the United States Navy. The minima occurred as usual on about one-quarter of the length of the ships from the ends. In the third column are given what are considered appropriate values for the corresponding spacing of the bulkheads at the points when the floodable length is a minimum.

TABLE I

Length of ship, L	Minimum floodable length, f	Spacing of bulkheads, s	Standard of subdivision
Feet	*Feet*	*Feet*	
400	70	65	One-compartment
500	90	45	Two-compartment
600	110	50—55	Two-compartment
700	125	60	Two-compartment
900	160	50	Three-compartment

Ships of less than 500 feet in length cannot, according to this table, be subdivided in a satisfactory manner to the two-compartment standard throughout their length and are not, therefore, suitable for the transport of troops. Ships of more than 500 feet in length may be subdivided according to the two-compartment standard and may reach the three-compartment standard amidships, but the latter standard can probably not be attained throughout and to full advantage in ships of less than 800 or 900 feet in length. Higher standards relative to the length of the ship may be attained, but only by carrying the bulkheads up to a rather unusual height or by a reduction in the carrying capacity of the ship; that is, by a disproportionate height of freeboard of the bulkhead deck and a low draft. One-compartment ships may, of course, be employed for the transport of troops in an emergency, but should ordinarily be used only as supply vessels or other auxiliary duty.

Differences of opinion will no doubt exist as to the numerical values to be adopted for the probable extent of damage by an explosion, the practicable minimum spacing of bulkheads and the assumptions on which the floodable lengths should be calculated, but this does not affect the soundness of the principles here stated. The main results of the investigation, as relating to troop transports for ocean service and on the present standpoint of submarine weapons, may be summarized as follows:

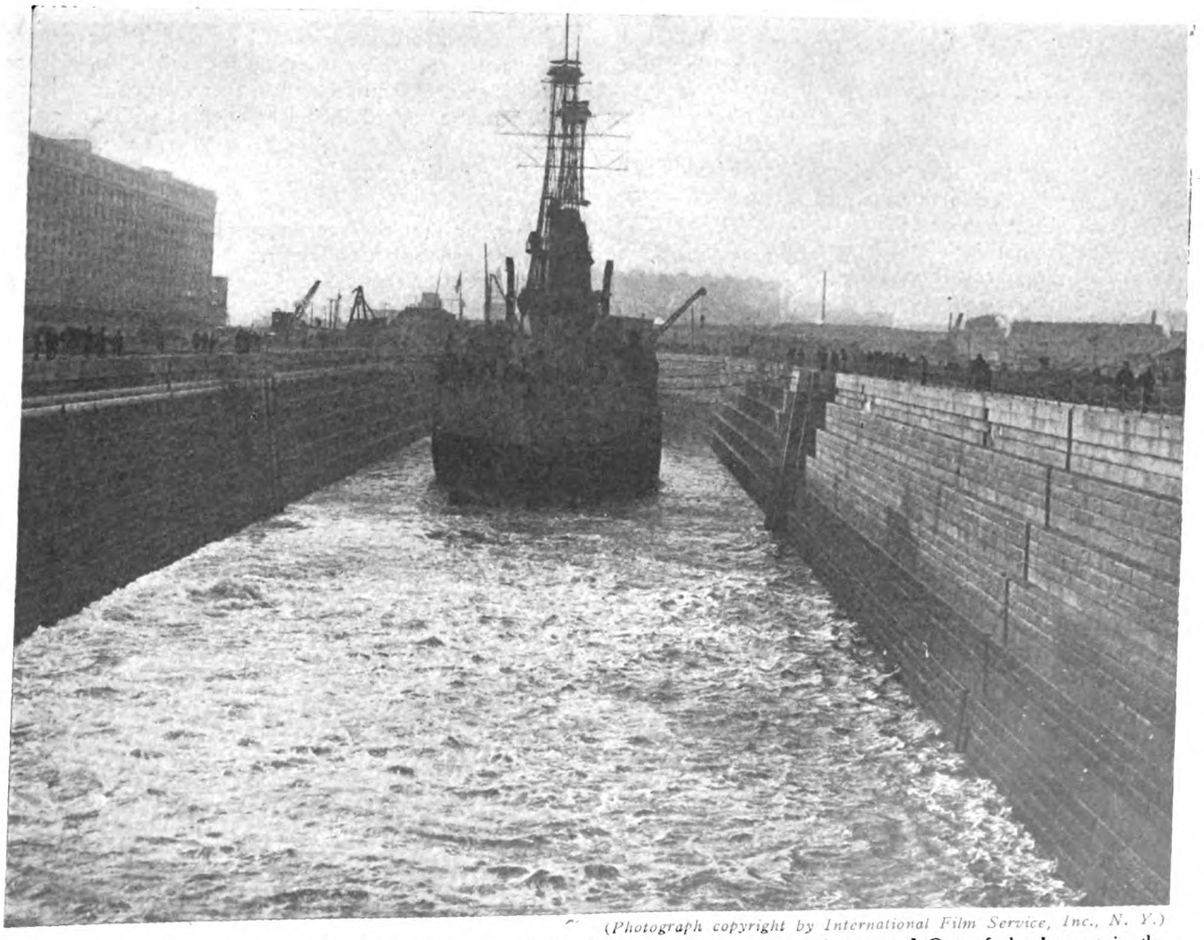
1. Troop transports should have a length of not less than about 500 feet.

2. The freeboard of the bulkhead deck and the sheer should be such that when the ship is on her deepest draft, and with reasonable assumptions as to permeability, she will conform at least to the two-compartment standard throughout her length.

3. Excepting the extreme ends of the ship, the spacing of transverse main bulkheads should not in general be less than about 45 feet.

4. Whichever standard of subdivision is adopted, the spacing of the bulkheads at any point of the ship should be the greatest practicable consistent with that standard.

(To be concluded.)



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Battleship *Virginia* Floating into the Big South Boston Drydock, the Largest in the United States, and One of the Largest in the World. The Dock, Built by the State of Massachusetts, Was Taken Over by the Navy Department and Was Formally Opened Early This Month

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Electric and Oxy-Acetylene Welding at the Bethlehem Fore River Shipyard

WHILE the welding department is one of the youngest of the departments at the Fore River plant of the Bethlehem Shipbuilding Corporation, yet it is one of the most interesting. Its duties up to within a year or so ago consisted chiefly in acetylene burning and cutting, and minor welding jobs, most of which were connected with machine repairs. Since the war, however, with the wonderful development and increased application of the electric welding process, operations of this department today affect nearly all of the departments in the plant.

While the advantages of the application of welding in shipyards are not fully recognized, the items mentioned in this article show how extensively many departments of this plant, at least are finding this process a time and money-saving proposition.

As the plates and shapes are brought into the ship shed to be layed off from the molds, the welding department begins its operations. Burners cut the openings in the plates for doors and hatches, trim the edges to the curves and lines laid out from the molds, burn out the lightening holes, and make other cuts that are impossible or more expensive to make with the shears and punches.

Smith Shop Work

In the smith shop the burners also cut holes in girders, notch angles and frames, split beams and work on innumerable pieces in conjunction with the smiths. Here also the welders join together gun foundation rings, blower trunks and smoke stack rings, add pieces to staples, etc. Boat davits and trolley supports split by the burner and bent into the required shape by the anglesmith are rapidly welded into solid pieces by the electric welder. Similarly, stiffening bars are split and welded, condenser frames are formed and false corners inserted and welded into solid pieces. Application is also made of spot welding machines to join elementary pieces, supplanting the use of rivets in some members entirely.

Fig. 1.—Burning

Fig. 2.—Anglesmith Inserts

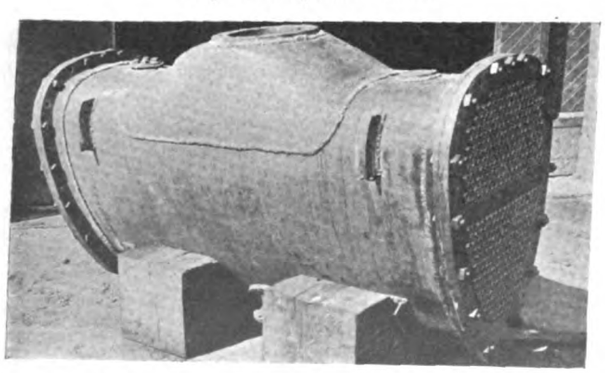

Fig. 3.—Destroyer Condenser Electric Welded

Fig. 4.—Cocoa Matting Holders Welded to Deck

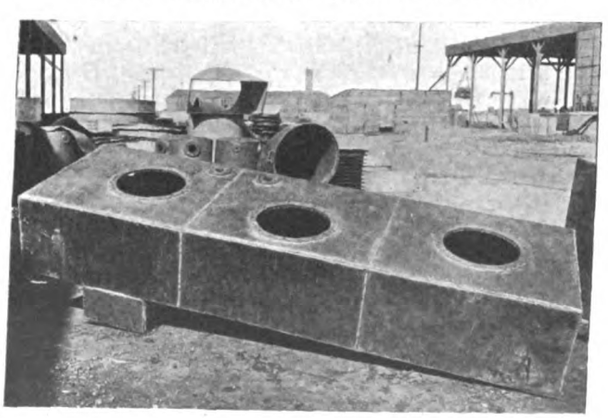

Fig. 5.—Lubricating Oil Tank Completely Welded

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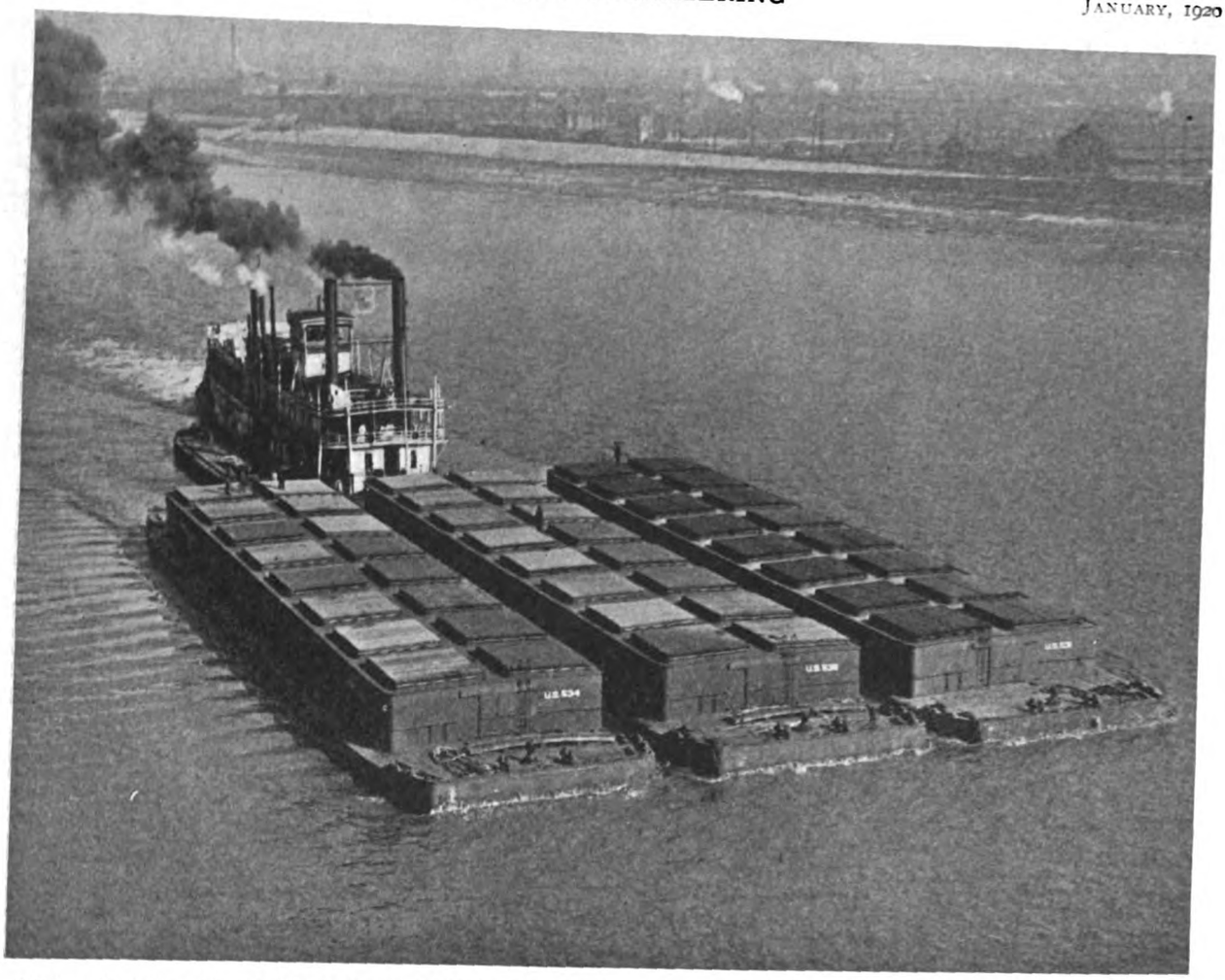

Modern Steel Cargo Barges of 2,000 Tons Capacity, Designed by Cox & Stevens, Naval Architects, New York, in Service on the Mississippi River

The accomplishments of the cutting torch are again in evidence throughout the assembly space. Plates are burned to suit irregular castings, frames and shapes are altered to join with bars and clips coming together on the way to the boats. Welders join more bars and fasten pads to bulkheads and weld up inaccessible corners so that the ship will be tight and strong. Here are fastened in place rings with strips welded on to accommodate the proper number of rivets.

Hull Work

On the hull burners cut the major openings, such as the sea chest openings, holes for rudder carriers, shaft tube holes and a great variety of other holes. The electric welding process is used to weld the struts to the shell collars and the propeller guards at the junction of the tubing of the pads. Here also many irregularities in the stern and stem castings are quickly filled in by electric welding.

In some cases very large savings are effected by the welders in a few hours on castings in which drilling and other operations open up flaws which have been impossible to observe before hundreds of dollars' worth of labor have been spent on them. The welders repair these flaws without necessitating the removal of the parts from the hull and in many instances without interrupting the normal progress of the work on the piece.

Before the ship is launched the welders and burners serve many departments by cutting holes for pipe systems, ventilation systems, electrical systems, etc. The welder is constantly called upon to fill in holes in bulkheads and decks, in connection with alteration of plans, which relocate foundations and supports after the construction is well under way. In cases of this nature also great savings are made in the cost of construction, as it is not necessary to tear apart whole sections of decks and tank tops to build in new parts, as was necessary before the introduction of electric welding.

Welding at the Fitting-Out Docks

In connection with the work at the fitting-out docks, still other departments are making application of the new process. On the destroyers the cocoa matting strips are all fastened to the deck by welding in place of rivets. A great number of miscellaneous deck fittings, consisting of items such as waterway bars, meat block rings, galley furniture, deck fittings, ventilator coamings, stovepipes, racks, boxes, etc., are electrically welded.

Electrically welded ladders of gratings which are welded to the bulkheads and decks without the use of rivets give access to the lower decks, where a large variety of work is found fastened in place without any screws, bolts or rivets. All of the strips for the metal ceilings are welded in place. Pipehangers or brackets are made a part of the hull itself by means of welding. Pipe stanchions are rigidly welded in place. Air chambers and

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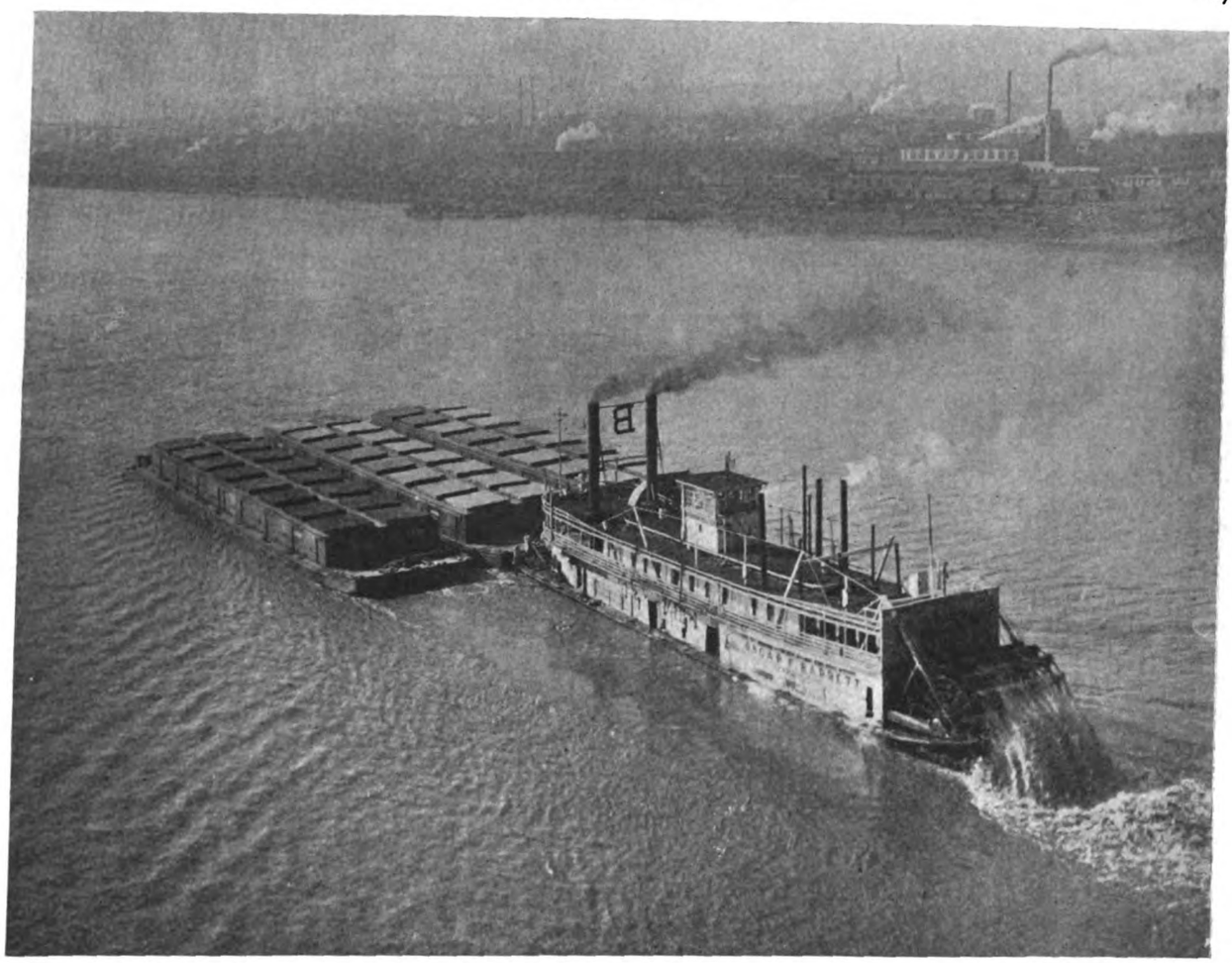

Three Abreast the River Barges Are Towed by a Sternwheel Towboat. The Barges Are 230 Feet Long, 45 Feet Beam and 11 Feet Depth

other parts of piping systems, which are tested as high as 600 pounds per square inch, are also electrically welded. Clips, brackets and supporting frames for the instruments for the electrical department are quickly and securely fastened to frames and bulkheads by the same method. Furniture clips, mess table pads, metal lockers and many other parts are welded to the decks.

Welding Supersedes Riveting in Sheet Metal Shop

In the shops welding embraces a wide field of work. Welding has superseded riveting in the sheet metal shop for use in the manufacture of ventilation pipes, fairweathers, gear covers, port casing, fuel oil inspection tanks, bins, racks, frames, windshields, gravity tanks, drain boxes, and other articles too numerous to mention. In some cases a very large saving in cost has been effected by the application of welding in place of other methods of joining the various parts in process of construction. The spot-welded smokestacks are a noted example of this.

In the machine shops the welders reclaim broken parts of tools, build up worn shafts, reclaim defective castings, repair broken teeth in gears, and many other articles. An illustration of the economy secured by welding is the use of this process in making cutting tools. Small pieces of expensive high-speed steel are welded to inexpensive steel shanks, making efficient and economical tools, which were formerly made entirely of high-speed steel. Many pneumatic and electrical tools are repaired and put back into service by adding a little metal here and there by means of this wonderful "putting on tool," the electric arc.

In the maintenance work the welders at Fore River have to their credit some of the largest jobs of this kind in the country, not excepting the much advertised repairing of the machinery in the damaged German ships. Hydraulic machinery, steam hammers, straightening rolls and many other of the most powerful tools at the pla have been quickly and successfully repaired by welding.

Example of the Baldbutte

The S. S. *Baldbutte* is a pleasing tribute to the skill of the electric welder, inasmuch as welding played a larger part in the construction of this ship than any previous vessel. The hatches over the engine room, boiler room, galley and mess rooms are completely welded. Railing stanchions, awning stanchions and many other fittings are fastened to the deck by this process; even Old Glory waves from a staff the socket of which is welded to the deck.

Mississippi River Barges in Service

The photographs on this and the preceding page illustrate the manner in which the tows of steel cargo barges designed by Cox & Stevens, naval architects, New York, for the United States Railroad Administration are handled on the Mississippi river. The tow in this case is made up of three barges abreast, propelled by a sternwheel towboat in accordance with the regular western river method of navigation. These barges are 230 feet long and have a cargo carrying capacity of 2,000 tons each.

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A Forty-Knot Destroyer

THAT the highest speed ever attained by a warship should be developed by a destroyer built by Messrs. Yarrow & Company, Ltd., of Scotstoun, Glasgow, is not surprising. For many years this concern has specialized in the construction of high-speed vessels—notably destroyers—and the reputation earned by vessels designed and built at this plant has been an enviable one. Such results have been made possible, however, only by the extensive experimental and research work carried out by this firm, and their latest achievement is a fitting reward for years of painstaking effort. The vessel which has set a new world's record for high speed is the destroyer *Tyrian,* of 1,060 tons displacement, which on December 16 obtained a speed of over 45 miles an hour, or better than 40 knots, on an Admiralty four-hour official trial in deep water. Had the vessel been run in shallow water, a considerably higher speed would undoubtedly have been obtained, so that the performance is all the more remarkable. The *Tyrian* has a length of 273 feet and is fitted with turbine machinery supplied with superheated steam by the latest type of oil-burning Yarrow watertube boilers.

National Marine Week

TO arouse the people of the entire country to take an active interest in the American merchant marine, a series of demonstrations, nation-wide in scope but centering in New York, will be held from April 12 to 17 under the auspices of the National Marine League. Recognizing that the time has come for the nation to realize the pressing economic importance of national maritime independence, the Marine League is leaving no stone unturned to stimulate public interest in marine affairs, and to secure the co-operation of all who have the interest of the American merchant marine at heart.

During "national marine week" interest will center chiefly in the marine exposition which will be held in the Grand Central Palace in New York. This exposition, the first of its kind to be held in this country, will consist of exhibits of maritime relicts, ship models, inventions, shipbuilding methods, etc., including Government exhibits. Although the exposition will be held in New York, the scope of this demonstration will be nation-wide, and an elaborate scheme of publicity will be utilized to focus the attention of the people throughout the country upon maritime problems. The plans for this demonstration so far disclosed are the most ambitious that have yet been proposed for stimulating interest in marine affairs and will have a salutary effect upon the nation, which hitherto has been altogether too indifferent to its welfare as a maritime power.

The Navy's Need of a Merchant Marine

THREE sound reasons why the navy needs a merchant marine are given by the Secretary of the Navy in a recent statement published by the Atlantic Coast Shipbuilders' Association. To naval officers and those who are vitally interested in the development of the United States as a maritime nation, these reasons are in no wise novel—in fact, they have constituted one of the strongest arguments which for years both naval officers and laymen have used in their endeavors to arouse their fellow-countrymen from their indifference to the safeguarding of the prosperity and welfare of the nation. Tardy as the Secretary of the Navy has been in recognizing the force of these arguments and taking active steps to impress upon the people the importance of the merchant marine to the navy, it is nevertheless refreshing to have these facts brought home from such a source even at this late hour.

That the merchant marine is an indispensable arm of the naval service in time of war, which was the Secretary's first reason for the need of an adequate merchant marine, has been amply proved by our experience in the Great War just ended. As pointed out by the Secretary, Germany's attack on the Allies at sea was, with the exception of isolated naval engagements, aimed wholly at the merchant marine of the Allies. The mission of the German Navy was to sink the tonnage of the merchant fleet of the Allies, so that their armies in the field would be unable to operate on account of lack of supplies. Had their attack been successful, the outcome of the war might have been an entirely different story.

The second reason advanced by the Secretary—that the merchant marine is a training school for seamen—is equally important, and the usefulness of a merchant marine for this purpose was again proved by the world war. The disparity between the war strength and peace strength of the naval enlisted personnel is so great that in time of war it is necessary to call into service thousands of inexperienced and untrained men. On the other hand, if the United States maintains an ample merchant marine, seafaring men will, as a result, be available, and the serious predicament in which we were placed at the beginning of the recent war would not be repeated.

As a third reason, the Secretary declares that an added merchant marine will enable the United States to take its proper place among the nations of the world in diplomatic and trade relations. Because the prosperity of our country is directly proportional to the success of our trade

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relations with other countries and the magnitude of our foreign trade, it follows that this prosperity will depend upon the ability of our merchants to place their wares in the hands of the foreign consumer without delay and in good condition. The only way in which this can be done is to carry our wares in American vessels owned and operated for the benefit of American industries—not in foreign vessels owned and operated for the benefit of our competitors.

If further argument is needed to show that an adequate merchant marine is a necessity, it is provided in the conclusions of Secretary Daniel's statement when he says that if our possible enemies know that we have an ample and efficient merchant marine they will not be prone to force a possible issue to the extent that war might result. An adequate American trade fleet is in itself a safeguard against declarations of war against the nation.

American Shipbuilding in 1919

BY delivering over 6,000,000 deadweight tons of merchant ships in 1919, American shipbuilders have established a record never before approached by any other country in the world, and a record which is likely to stand as a high water mark for some time to come. In addition to this, a large volume of naval construction, including battleships, cruisers, destroyers, submarines, hospital and ammunition ships, tugs and other auxiliaries, was at the same time under construction.

According to figures supplied just before the close of the year by the Emergency Fleet Corporation, the total number of vessels delivered to the Shipping Board during the year was 1,177, aggregating 6,325,398 deadweight tons. Of this amount, 748 vessels of 4,893,098 deadweight tons were of steel, 425 vessels of 1,418,800 deadweight tons were of wood, and 4 vessels of 13,500 deadweight tons were of concrete. During the year, keels were laid for 660 vessels aggregating 4,542,675 deadweight tons, and 1,087 vessels aggregating 6,058,037 deadweight tons were launched. Of the total net government shipbuilding programme (totaling 2,314 vessels of 13,628,611 deadweight tons), 1,757 vessels of 9,649,319 deadweight tons, or 70.8 percent, have been delivered; 248 vessels of 1,361,814 deadweight tons, or 10 percent, are being outfitted, and 261 vessels of 2,150,703 deadweight tons, or 15.8 percent, are on the ways, leaving 48 vessels of 466,775 deadweight tons, or 3.4 percent, still to be laid down. Considering only the steel ships, which, in the entire programme totaled 1,696 vessels of 11,588,011 deadweight tons, on January 1, 1920, 67 percent had been delivered, 11 percent were being outfitted, and 18 percent were on the ways, leaving 4 percent on which construction had not yet begun.

Although over 70 percent of the government shipbuilding programme is finished, there is no slackening up of work in American shipyards. On the contrary, the industry is steadily forging ahead and work for private accounts is replacing the government work. The shipyards today are building over a quarter of a million gross tons more than they were a month ago and nearly half a million tons more than in October. The total now under construction, exclusive of all government work, amounts to more than 1,200,000 deadweight tons of sea-going merchant vessels. In all this work for private account only one vessel is under construction for foreign owners, so that at present practically 100 percent of the work being done in American shipyards is for American owners.

This steady advance, according to a statement issued by the Atlantic Coast Shipbuilders' Association, is only one of the encouraging features of the development of the American shipbuilding industry. The shipbuilders themselves continue to show faith in the future of the American merchant marine by taking over contracts given up by the Shipping Board, and will complete the partially constructed vessels in the expectation of finding a market for them. Conditions indicate that they are justified in the belief that there will be a continued demand for American tonnage. The Shipbuilders' Association also points out that as matters stand today the United States is the only nation in the world in a position to supply merchant vessels quickly and in quantity, the British shipyards being tied up with orders for two years to come while other foreign countries are unable to supply the home demand and are seeking tonnage elsewhere.

The World's Oil Supply

AT the present rates of production and consumption the future oil supply of the United States is a matter of grave concern, according to statements by George Otis Smith, director of the United States Geological Survey. Last year the production of our oil wells was more than one-twentieth of the amount estimated by the Survey geologists as the contents of our underground reserves. We also drew from storage nearly one-fifth of what remains above ground.

Although it is true that the United States today is the largest oil producer in the world, yet it is also true that this country consumes nearly 75 percent of the world's output of oil, and the demand is steadily increasing. How this condition is likely to affect the shipping industry may be judged from the fact that the new demands of our ship programme alone involve fuel oil in quantities equivalent to nearly one-half of the domestic output, and unless there is some corresponding decrease in other demands, this new requirement must be met with an increase in production of nearly 200,000,000 barrels.

Two methods of handling the problem of a future oil supply are suggested by Mr. Smith: either reserve the domestic oil fields for American development and thus prevent foreign acquisition of what is needed at home, or encourage American capital to enter foreign fields to assist in their development, thus insuring an additional supply of oil for our needs. The first method obviously would be only a temporary solution of the problem and is hardly in keeping with the policy of other large oil-using countries. Whatever is done, the situation should be a forceful reminder to marine engineers of the necessity for improving the economy of power-generating machinery of every type which is dependent upon the use of oil as fuel.

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Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

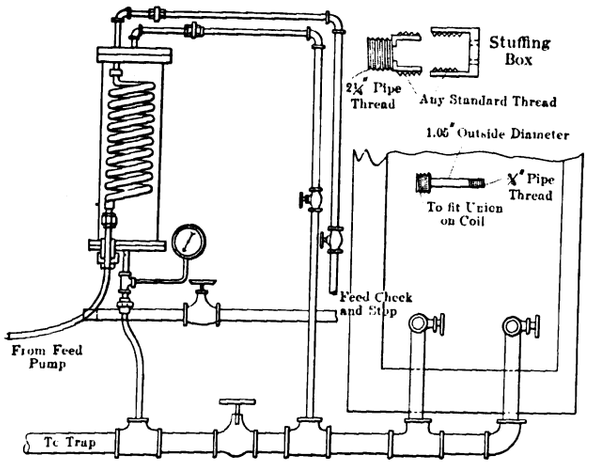
This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Increasing Evaporator Efficiency

Recently we have made an evaporator feed heater aboard our vessel, and I think that it has proved its worth and value, and other readers of MARINE ENGINEERING may find it profitable to construct one for themselves.

We have two units of Curtiss turbines of about 6,000 horsepower, also two DeLaval engines for the circulating pumps. The loss of feed water by steam leak from these is considerable. We have a Reilly evaporator with which we evaporated river water to make up the loss of feed water, but it was not possible to maintain the feed even by using the evaporator constantly.

The parts needed for the feed heater are easily turned out on a lathe. Use a piece of 7-inch pipe about 36 inches



Arrangement of Evaporator Feed Heater

long, with two blank flanges. Drill and tap two ¾-inch pipe taps in one of the flanges. In the other flange drill and tap for ¾-inch and 2¼-inch pipe. Place one of the evaporator coils in the pipe and lay off the position of the 2¼-inch hole. Turn out two fittings for the unions on the coils, making the male with a nipple about 6 inches long. One of the unions can then be screwed into the flange ends. One nipple has to be threaded about 3 inches, and may be screwed into the flange. A simple stuffing box may be made for the other nipple to pass through. Place the coil in the pipe, one nipple through the stuffing box and then bolt up the flanges.

The whole apparatus can be secured to the bulkhead near the evaporator by iron straps. Put a valve on the evaporator drain and a "T" on either side. Run pipe from the nearest evaporator to the upper end of heater, and place the valve in this line. From the bottom of the heater run a line of pipe to the "T" on the farther side of the valve. It is advisable to place a low-pressure steam gage on this line. Now place a stop valve on the feed line to the evaporator, and pipe from either side of this valve to the heater; run water from the pump to the bottom end of the heater and from the top of the heater to the evaporator.

By using the valve on the drain line and having the drain valves opened wide the pressure can be regulated in the heater to about 5 pounds, obtaining sufficient pressure to dump the trap and still getting the greatest amount of heat from the steam. The heater will raise the temperature of the feed water to about 180 degrees Fahrenheit and the evaporator will do 100 percent more work on less steam pressure. Care must be taken not to raise the temperature too high in the heater, because the heater will become salted and dirty and need cleaning.

Cleaning may be accomplished very easily by opening by passes on the drain and feed lines, securing other valves to and from the heater. Remove the bottom flange and lift the top flange out, the coil coming with it.

Anyone troubled by not being able to make up sufficient feed water with an evaporator I recommend their trying this feed heater, and they will be surprised and pleased by the fine results. Also it has a saving in itself, for reserve feed tanks can be filled with river water on either side of the Atlantic; and the evaporator can be used, as the water obtained in some ports is not only expensive, but very hard and poor feed for watertube boilers.

Philadelphia, Pa. F. T. HOBLEY.

Value of the Ejector

Several steamers have foundered in the Atlantic during the last few months, although there has been no very severe weather so far this season. These ships went down from the inability of the pumps to keep them free of water, and from no cause of the pumps themselves, but from the fact that the bilge suction strainers were so covered with refuse that the water could not get through to the suction pipes.

Whenever this happens the normal water service used for cooling the working parts of engines, together with the usual leaks in the engine room, quickly raise the water in the bilge to such a height that a man has to dive down to the strainer box to clean it.

In a heavy seaway this is a dangerous thing to do, for in many ships the bilge suctions are placed in a section between two tanks with only a manhole through which to reach the strainer. If the man is swept away he is like one who has fallen through a hole in the ice—"up against it."

In such an emergency there is one thing, however, that an engineer will turn to if he has it on the ship, and that is the ejector, or siphon, as it is called.

This instrument blows the water out in a continuous stream as long as steam and water are supplied. The suction pipe to the ejector, by the use of a couple of elbows, can be made to lift up, so the strainer on the end can be cleaned. A smooth-bore suction hose which can be dropped down in any part of the bilge is very handy. This hose may be kept up out of the way of oil when not in use. There should be one of these siphons on each side of the engine room.

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The objection to installing an ejector is that a ship has pumps and that pumps are more economical in the use of steam than a siphon. Even so, if one of these little machines is able to save one ship out of a hundred the cost should not be thought of.

The steam valve can be locked and the key kept in the chief enginer's room, so that the machine need only be used in case of necessity, when the ship's pumps—be there ever so many aboard—cannot get the water that is rising in the ship.

New York, N. Y. F. C. GETLIFFE, Marine Engineer.

Some CO_2 Compressor Valve and Gland Packing Defects, with Their Remedies

During the homeward-bound voyage of the vessel on which the writer was assistant refrigeration engineer, the following incident occurred when the ship was well on towards the line of the equator, with a full cargo in all the refrigerated holds.

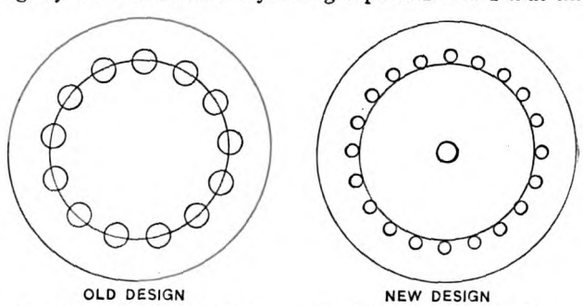
The refrigeration plant was composed of two duplicate sets of CO_2 machines, formed into separate units, each compressor being driven by a compound steam condensing engine, with cylinders placed in tandem. The tail rod of the steam set was connected to the gas compressor rod by a suitable coupling. The compressors were secured to the vertical framing at the end of the sole plate, and were overhung, inasmuch as there was no other support. The gas suction and delivery valves were made of flat disks of steel, and when the compressors were opened out for the renewal of bucket and gland leathers the opportunity was always taken to withdraw these valves for examination. If they showed the slightest sign of any defect, such as a cracked opening however minute, they were rejected and spare valves, of which we carried a fair supply, were substituted. The valve casing or cage was cunningly constructed so that in the event of a valve breaking into two or three pieces these pieces would be prevented from being drawn into the compressor.

Shortly after taking over my watch I started up one of the machines. They were each rated at 75 tons refrigeration per 24 hours, and one set was capable of maintaining the cargo at the required temperature, though the chief refrigerating engineer usually operated one machine on his watch and I ran the other, thus insuring both sets being in first-class order in case of an emergency. It soon became evident that one of the compressor gas suction valves was inclined to jam momentarily away from its seat so that on the return stroke of the compressor bucket the gas at the evaporator pressure (150 pounds) was forced back into the suction pipe instead of being compressed. This caused the machine to suddenly accelerate its speed for a few revolutions, the defective valve always closing before the end of the stroke. At every stroke the valve was sent to its seat with lightning-like rapidity.

I did not consider at the time that it would be wise to close down the machine, hoping to complete the necessary run of a few hours, when in the ordinary course of events the compressor would be opened up and a new valve fitted. The inevitable happened, however, and the valve fractured, allowing the machine, with its heavy flywheel, to race badly for a few seconds before I was able to shut off steam. On opening up the suction valves we found one of them broken in two, and as the trouble with suction valves had become somewhat frequent of late, the chief engineer decided that some change in design was urgent. After a time, during which several ideas were submitted, the altered design shown in Fig. 1 was arrived at. As we had a lathe on board and plenty of white metal, castings were made of the desired shape and machined and finished to size so that the new fittings could be quickly procured when we arrived at our destination. The new valves proved to be superior to the old design and displaced them during the remainder of the time I was on that vessel.

HYDRAULIC LEATHERS USED TO MAKE COMPRESSOR GLANDS GAS-TIGHT

While writing of CO_2 machines I may mention that the compressor rod glands were made gas-tight by the use of hydraulic leathers held to their shape by rubber rings. These rings usually were used only once, that is, they were discarded when new leathers were fitted. This became rather costly, and I tried wrapping the rings tightly with electrician's jointing tape and found that this



OLD DESIGN

Defects. Insufficient Initial Area for Gas in Compressor to Effect Closing of Valve and Suction Gas Throttled

NEW DESIGN

Total Valve Area Utilized to Close Valve and Flow of Gas Not Impeded

Fig. 1

enabled us to lengthen the life of the rubbers so that they could then be used again.

We often had a run of bad luck with the compressor gland leathers giving out entirely when we were hard pressed in tropical seas, with the high temperature condensing water at, say, 86 degrees to 90 degrees F. when lying in such ports as Colombo or Bombay. Once the gland leathers carried away suddenly, and the resulting smoke screen, if one may so term it, of vaporized sealing oil and heavy carbonic acid vapors made it rather difficult to reach the engine stop valve to shut off steam. The leathers were pressed in the mold, and while so fixed were placed under the high-pressure cylinder to receive a certain amount of heat treatment. After trimming the rough edges of the cup leathers they were removed from the mold, and just prior to being fitted to the compressors were immersed in kerosene for about 10 minutes or less. The result of this latter treatment was simply astonishing. One set of gland leathers so treated gave perfect service during the whole of one voyage which lasted for nearly four months. The machine was run under all the varying conditions incidental to everyday practical refrigeration, viz., the compressor frosting up and, again, the compressor rod running warm; also under the trying conditions of tropical seas, when the condensing pressure amounted to 1,100 pounds per square inch.

On another occasion, when the ship's refrigerating plant consisted of a small duplex machine of about 15 tons capacity, used only for maintaining the ship's stores, and a small cargo chamber at freezing temperatures, we experienced a great deal of trouble with unsuitable gland leathers while away on commission. As our stock of spare leathers became seriously reduced we were soon faced with the imminence of a compulsory stoppage of all re-

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frigerating apparatus, with the consequent loss of our refrigerated stores and cargo. We eventually overcame the difficulty by designing, making and fitting a new style of packing (Fig. 2), which enabled us to carry on until we reached port and replenished our exhausted gland leather supply. The white metal used was rather soft and of the "lead base" variety, and, as this ship's equipment included an invaluable lathe, we soon had the new rings turned out and carefully fitted (a good sliding fit to the spare compressor rods and also to the bore of the gland orifice). Special pains were taken to taper the white metal rings to a knife edge, and they were carefully inserted along the rod to insure that the fine edges of the sensitive white

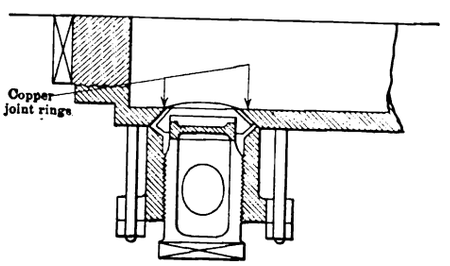

Fig. 2.—Half Section CO_2 Compressor

metal should remain unblemished and make as good a joint as possible at the commencement. This packing ran well, but great attention was given to the machine to keep the rods at as even a temperature as possible.

I have had experience with the new white metal packings now supplied to this make of CO_2 machine and can only say that, in my experience, this departure is the last word in gland packings, as, given proper care and intelligent handling at the start, they soon build themselves up to their duties and then run gas-tight under practically all usual conditions and give no trouble.

Port Chalmers, N. Z. W. I. ESPLIN.

Why the St. Saboda Was Late

Is there an engineer anywhere who doesn't hark back occasionally to the good old days of apprenticeship—to the days of bitter-sweet remembrances—and instantly recollect some incident, accident or repair, amusing or otherwise, that warms his heart, quickens his blood or blurs his eye?—and finally pop goes his safety valve and he spills the whole story.

Claiming no exception to the rule, though I am now in the stationary game by choice, Neptune once knew me and bore compassion. 'Tis a long hail from here to the salt Pacific, but not so far that I can't smell the "beeswax" cylinder lubricant frizzling on the cylinder heads and my mind is wafted off to green fields and clover with the glorious, fragrant perfume of it.

Beeswax as a lubricant is rather antiquated, no doubt, and perhaps has passed into history now, but the fact remains, although it was never used in very large quantities, as may well be imagined, it has its advantages.

However, in marine work the vertical inverted engine requires little, if any, lubrication, and that confined to "swabbing the rods," as the saying goes, in the old days with a combination of wax and low-quality steam as the necessary ingredients.

But a time of trouble came to us on one voyage, as it has a habit of doing at sea, although it was not particularly traceable to the inefficiency of the lubricant. It all began with a heartrending thump in the intermediate cylinder, which, being repeated at odd intervals, aroused the "gang" to action. The ship's engines were closed down to quarter speed and a hurried external examination made, which revealed absolutely nothing.

As everything seemed intact and serviceable and no further indications of pending disaster occurred, speed was again cautiously resumed. No sooner had the wheel turned over a few times than the thumping was repeated, this time far worse and more frequently than before.

The chief engineer was entirely cool, though Scotch. It was evident, however, that the difficulty was a new one to him. He gave orders to stop ship when he found there was sufficient sea room, and to put in the jacking gear to keep the engine from moving in the sea-way, also to take off the head of the cylinder giving trouble. All this was done for inspection.

To our entire surprise, nothing unusual came to view on the careful examination then given the cylinder. There was nothing broken, nor did any loose follower bolts show.

Everything looked ship shape and without a mark to indicate what the trouble could be to cause such a commotion.

One revolution of the engine by means of the jacking gear permitted the inspection of the cylinder bore, and the checking of the striking points revealed nothing. Handhole inspection at the bottom end had a like result.

The chief lit a cigar while the ship rolled in the trough of an oily sea and a few white faces of voyagers anxiously peered down from the skylights overhead.

Almost stumped, he sat there on the elevated platform, his feet dangling in midair, silent and thoughtful. The second cigar, too, was lighted, while the crew sat in silence, apparently not to distract the deep thought of the chief.

But no—one old "chaw" broke the quiet when an unusually heavy sea threw him off his soap-box, and was heard to remark something about a "blarsted old walloper, wud roll th' feathers off a goose."

"Pike! Just measure the distance that head sets into the piston." "Eight inches, you say?" "And it's seven and three-quarters drop into the counterbore before you strike the liner!" "Well, it's a cinch the liner is working."

By the aid of two small jacks, some blocking, strong backs and so on, we forced the loose cylinder liner down into its place four inches below the bottom of the head when in its normal position.

Meanwhile the cylinder head had been turned over and lashed, the engine-room machine shop (the old man's strong back and a ratchet drill) assembled and four holes drilled into the bottom of the head and tapped for one-inch stud bolts, which were screwed into place and left projecting 4 inches. When the head was replaced the four studs met the narrow edge of the cylinder liner thus preventing its up-and-down travel and eliminating the cause of the disturbance. The jacking engine was started and a turn taken out of the engine. As all seemed clear, the gear was taken out and the main throttle opened to give the engine a few turns either way to test the propeller.

"All clear," the telegraph bell rattled like a ruptured dishpan. "Full ahead!" came the reply. The quick rush of steam, her pulse steady, the old *Saboda* took the bone in her teeth and headed north.

The chief engineer walked out into the stokehold with a twinkle in his eye. "All right, boys, shake her up. We're only three hours late; we can make Seattle before they close up—and you, Kelly, can "get into" that after starboard bunker while ye are resting yourself. Ye'll find good Nanaimo coal in thar."

Holyoke, Mass." HARRY A. LIVINGSTON.

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Machinery Weights

Q. (1028).—Please publish an approximate formula for estimating the weight (wet) for the following types of machinery installations based on indicated horsepower or shaft horsepower: Scotch boilers with turbines and reduction gear, watertube boilers with turbines and reduction gear, and watertube boilers with reciprocating engines.

A. (1028).—Your question, if taken to include naval together with merchant (passenger and cargo) practice, would cover such a wide field that it seems best to limit it to only the ordinary freight steamship. You also should realize that using merely the shaft horsepower or indicated horsepower as a basis does not allow for the variation in revolutions per minute with different reciprocating engines (merchant types may vary from 65 to 95) for the fact that the heating surface of the boilers chosen in some particular case may be different from that upon which our formula is based.

Approximate Machinery Weights

1. Reciprocating engines and Scotch boilers, .220 ton per indicated horsepower.
2. Geared turbines and Scotch boilers, .225 ton per shaft horsepower.
3. Reciprocating engines and watertube boilers, .185 ton per indicated horsepower.
4. Geared turbines and watertube boilers, .190 ton per shaft horsepower.

In using the above ratios it must be realized that they obtain for about 1,000 to 4,000 horsepower installations. It appears to be customary in watertube installations to provide a greater amount of heating surface in proportion to the horsepower than for Scotch boilers, possibly in part due to the fact that watertube boilers come in standard sizes, while Scotch boilers are usually made up by the shipyard, and also due to the heating surface of the Scotch boiler being more readily cleaned while the boiler is in operation.

Machinery weight is here considered to include all engines, pumps and piping in the engine and boiler rooms, together with stack, uptakes, floor plates, propeller, shafting and bearings. The weights for the turbine installations are based on the use of condenser equipment of the same type employed with reciprocating engines.

In obtaining the weight of existing installations, it would seem better practice to use a formula containing more variables. A paper by Professor McDermott (Transactions of the Society of Naval Architects and Marine Engineers, 1897, page 180) gives some interesting formulae, a few of which are here quoted:

Engine Room Weights

Engine room weights include main engines (except shafting, bed plates, shaft bearings, cap bolts, etc.), auxiliary engines, all pump connections, condensers, water in condensers and pipes, pipes in engine room, tools, workshop fittings, platform gratings, ladders, ventilation fans to engine room.

D = sum of squares of diameters (inches) of each cylinder.

L = stroke (feet).

N = number of engines.

Weight in tons = $.018\ n\ [(DL)^{\frac{2}{3}} + 390]$.

Shafting

(Crank, line, thrust, propeller shafts, engine bed plates, caps, bolts, etc.)

D^2L = sum of [diameter (inches)^2 × length (feet)] of crank, thrust, line and propeller shafts.

Weight in tons = $.0026D^2L$.

Note.—Caution should be used in applying this formula to vessels having engines aft.

Boiler Room Weights

(Boiler mountings, uptakes, smoke stacks, pipes in boiler room, forced or assisted draft arrangements and appliances, ventilating arrangement, ash hoist, stokehold plates, platform gratings, ladders, fire bars, tools and water.)

Scotch Boilers.—Water 8 inches above top row of tubes.

L = mean diameter (feet).

HS = heating surface, one boiler.

N = number of boilers.

Boiler Room Equipment.—Scotch, single-end.

Weight in tons = $.0085\ N\ [D^2\ (L + 2) + HS] + 10\ N$.

Propellers

(Boss, blades and bolts.)

D = diameter in feet.

S = surface in square feet.

N = number of propellers.

Three-bladed, detachable-blade, steel or bronze propellers.

When $D\sqrt{S} < 50$

Weight in tons = $.03\ ND\sqrt{S}$.

When $D\sqrt{S} > 50$

Weight in tons = $.11\ N\ (D\sqrt{S} - 36.3)$.

Four-bladed, detachable-blade, steel or bronze propellers.

When $D\sqrt{S} < 50$

Weight in tons = $.028\ ND\sqrt{S}$.

When $D\sqrt{S} > 50$

Weight in tons = $.10\ N\ (D\sqrt{S} - 40)$.

For cast iron solid propellers add 20 percent to the above.

For steel or bronze solid propellers deduct 25 percent from the above.

For cast iron propellers deduct 10 percent from the above.

It has been estimated that internal combustion engines now furnish approximately two-thirds of all the prime motive power generated in the world. Those burning gasoline (petrol) furnish about 95 percent of this motive power.—*R. B. Blakely before the American Society of Mechanical Engineers.*

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Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

BIG DEMAND FOR TANKERS KEEPING AMERICAN SHIP BUILDERS MORE BUSY

Each Month Shows a Gain in Orders—Lead of Freighters Reduced—Speed of Production Great Factor in Obtaining Contracts—Work Gets Top Rating.

"American shipyards, instead of falling back as Government contracts are suspended, cancelled or completed, are forging steadily ahead," says a statement just issued by the Atlantic Coast Shipbuilders' Association. "Work for private accounts is replacing that which was being done for the Shipping Board, and although a number of orders for American industries have been completed or withdrawn during the past few weeks, the shipyards to-day are building over a quarter of a million gross tons more than they were a month ago, and nearly half a million tons more than in October. The total now under construction, exclusive of all Government work, is 805,000 gross tons, the equivalent of more than 1,200,000 deadweight tons of sea-going vessels.

"This steady advance is only one of the encouraging features in the development of the American shipbuilding industry. The shipbuilders themselves continue to show faith in the future of the American merchant marine by taking over contracts given up by the Shipping Board, and will complete the partially constructed vessels in the expectation of finding a market for them. Conditions indicate that they are justified in the belief that there will be a continued demand for American tonnage.

"As matters stand to-day, the United States is the only nation in the world in a position to supply merchant vessels quickly and in quantity. The British shipyards are tied up with orders for two years to come. Other foreign countries are unable to supply the home demand and are seeking tonnage elsewhere. There is nowhere to place orders for prompt delivery but in the United States, and only the unfavorable position of the exchange and the insistence upon long term credits are keeping back a flood of foregin orders. While American tonnage prices are still only about ten per cent above the British on a basis of currency parity, the high value of the dollar in comparison to the monetary units of other countries, due to the abnormal exchange situation, temporarily imposes upon the buyer of American products a handicap of twenty per cent. As soon as the exchange begins to right itself, however, European shipowners are expected to place contracts in this country.

"The factor of speedy delivery," the statement continues, "is a powerful asset for American shipyards. Leading British shipbuilders who have visited the principal plants in the United States frankly admit that the output here is at the rate of two to three times that of the British yards. This means that, shipway for shipway, this country can produce double to treble the tonnage that Great Britain can. Furthermore, with the great rapidity of turnover, the American shipbuilding industry is getting so much more service out of its plants that this factor will result in a marked lessening of production costs that will enable the United States to meet England's prices, which are at present lower because of cheaper labor.

"That speed of production, due largely to the employment of more modern methods and the greater use of labor-saving devices than in Britain, has not lessened the quality of American-built ships, is plainly manifest. Since the armistice, Lloyd's Register of Shipping, a British institution, has supervised the complete construction of nearly six hundred steel steamers in United States yards, and has rated every one of them 100-A1, the highest class given.

"The showing of the American yards is the more remarkable in that of 152 ships now being constructed for private account only one is to foreign order. At present, therefore, American industry is providing practically 100 percent of the work being done, in spite of the fact that the Shipping Board is trying to dispose of hundreds of completed ships on liberal credit terms.

"The total of 805,000 gross tons under construction does not represent all the work American shipbuilders have in hand, for additional contracts which have been placed, but upon which operations have not been begun, will bring the total to more than 1,000,000 tons.

"Details of the work actually under way have been prepared from official classification records of the American Bureau of Shipping and Lloyd's Register. An analysis of these figures shows that the volume of orders has been increasing steadily, both November and December marking increases of about 50 percent over the previous month, the totals under construction for the three months being: October, 347,343 gross tons; November, 550,714 gross tons; December, 805,147 gross tons.

"The rapidly increasing demand for tanker tonnage, due to the recent marked development of the oil-burning ships here and abroad, is reflected in the returns. Whereas, in October, 160,000 gross tons more of freighters were being built than of tankers, at present the excess of cargo-carrying tonnage under construction is only about 30,000, as the following table covering the various types of tonnage for the past three months show—(totals in gross tons):

	Oct.	Nov.	Dec.
Freighters	235,523	295,493	400,556
Tankers	74,437	214,940	369,084
Other types ...	37,383	40,281	35,507
Total	347,343	550,714	805,147

To Recognize American Bureau of Shipping

Just before the adjournment of Congress the House Committee on Merchant Marine and Fisheries reported to the House of Representatives unanimously the bill, introduced by Representative G. W. Edmonds, of Pennsylvania, recognizing the American Bureau of Shipping as the official classification society of the United States. The bill differed from the one originally reported in two respects. An amendment directing recognition "so long as the American Bureau of Shipping continues to be maintained as an organization, which has no capital stock and pays no dividends," was made. A further provision that "the official list of merchant vessels published by the Government shall hereafter contain a notation clearly indicating all vessels classed by the American Bureau of Shipping," was added.

Will Build Steel Hereafter

A new steam trawler, the *Medric*, is about ready for launching at the yard of the Portland Shipbuilding Co., at South Portland, Me. She is the seventh boat of that class built at this yard for the East Coast Fisheries Co., and will be the last one to be built there, as only steel craft will be contracted for by the fish concern in the future.

Capt. E. R. Norton, superintendent of the local company, expects to find plenty of work in the other direction.

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CLYDE BUYS RAPOREL

Transfer of Steamship Interests Involves About 100.000 Tons

Announcement was made at the offices of the Clyde Steamship Company a few days ago that the company had acquired the steamship interests of Edward M. Raphel & Company and the Raporel Steamship Line. The Raporel Line will continue operation as heretofore, with its offices at 17 Battery Place. C. H. C. Pearsall, of the Raporel Line, expects to open a regular freight service from Philadelphia to Avonmouth and Hull within a few weeks, having already established an office in the Bourse building, Philadelphia.

In addition to maintaining a regular freight service between New York and Haiti, Windward and Leeward Islands and Virgin Islands, the Raporel Steamship Line operates eight Shipping Board vessels to the West Indies. These are the *Lake Ogden, Lake Sunapee, Lake View, Lake Narka, Ledan, Shawano, Atlantus* and *Connersville*. For owners' account Raporel is operating the steamers *Fordonian, St. Charles, City of Puebla, Deerfield* and *West Catanace*. The last two are refrigerators purchased from the Shipping Board by the Eldorado Steamship Company, of 50 Broad street. The *Deerfield* is running between South American and Northern European ports, and the *West Catanace* is in the Black Sea trade. Two chartered steamers are being operated by the line, the *Georgeanna Weems* and the *Dorothy*. The total amount of tonnage Raporel at present has under operation, including the Shipping Board vessels, is about 100,000.

STANDARD TO BUILD TWO

Cuyamel Fruit Company Adds to Its Combination Fleet

Two special type combination fruit and passenger ships are to be built by the Standard Shipbuilding Corporation for the Cuyamel Fruit Company of New Orleans, the contracts having just been awarded. Delivery has been guaranteed for the last of next May and June, and construction will be begun immediately. The steamers will be 235 feet long, 34 feet beam and 16 feet deep, with a speed of 11 knots and accommodations for 30 passengers. It is considered probable that they will cost more than $500,000 each.

The Cuyamel Fruit Company has two similar ships now being built at the Newburgh Shipyards, which will be ready shortly before the vessels just contracted for.

Another shipbuilding plant in New York is expected to land a large contract for private construction in a short time. It is understood to be dependent upon the flotation of a loan for $3,000,000, details for which are said to have been arranged. The yard is said to be in the position of being able to get the contracts if the loan is arranged, and the loan if the contracts are landed.

SHIPPING BOARD TO PUSH SALE OF 1,400,000 TONS OF WOODEN VESSELS

Many Will Be Offered to Foreign Buyers—Minimum Value of Fleet, $126,000,000—Anderson Contract Agreed On—Some Small Steel Vessels May Also Be Sold

Word comes from Washington that an intensive campaign to dispose of 400 wooden vessels here and abroad will shortly be begun by the United States Shipping Board. The Anderson Overseas Corporation will undertake to dispose of as many of these ships as possible to foreign interests.

A contract which will give a percentage profit to the corporation as sales agent is now being drawn up by the legal department of the Shipping Board. The terms of the contract have already been decided on, and as soon as the legal technicalities are worked out the contract will be signed and will go into effect.

The wooden ships average 3,500 deadweight tons each, and the total is $1,400,000 tons. The prices which have been asked for the ships by the Board have varied from $90 to $115 a ton, depending upon the terms of payment. The value of the wooden fleet on this basis is from $126,000,000 to $161,000,000, and the value of each vessel is from $315,000 to $402,500.

Under the standard terms asked by the Shipping Board, the wooden ships are sold for $90 a deadweight ton cash; $100 per ton with 50 cer cent cash and the remainder in eighteen months, and $115 per ton with 25 per cent cash and the balance in three years. The exact terms upon which the vessels will be offered to foreign interests have not been announced, but it is said that they will certainly not be more favorable than those offered to American buyers.

It has been known for some time that the Shipping Board is anxious to dispose of its wooden fleet. Sales have gone slowly in the United States because of the preference of Americans for steel vessels. The Board feels that to establish the American merchant marine on a permanent basis it is necessary to retain its better ships either under Government control or under the ownership of private concerns under the American flag.

The wooden vessels were constructed to meet the war emergency, and since the signing of the armistice have been a burden upon the Board. In its efforts to obtain a well balanced fleet the Board has announced its policy of selling not only the wooden vessels either to American or foreign concerns, but also any of the smaller steel ships up to 4,000 tons.

It is held that the medium-sized and larger vessels can be operated at a greater profit because of the lower percentage of overhead charge per ton of freight carried. There is a belief among members of the Board, however, that, while there is a surplus of tonnage available for sale here, there is a shortage abroad.

SHIP CASES DISPOSED OF

Payments of $18,300,360 Approved, Concerning 314 Cases

A record of claims disposed of by the Cancellation, Claims and Contracts Board of the United States Shipping Board Emergency Fleet Corporation, just made public, shows that since the signing of the armistice 314 cases have been approved for payment involving a total loss of $18,300,360. In 52 other cases advances have been recommended, bringing the total up to 366 cases involving $22,197,934.

The documents made public contain 201 cases which have been acted upon since Judge Payne became Chairman of the Board in August. Of these 164 cases were approved for payment, while advances were recommended in 37 others, the cases approved for payment totaling $14,856,620, and advances recommended totaling $2,357,759, a grand total of $17,214,379.

There were few claims settled where the amount allowed exceeded $1,000,000. The largest was granted to the McEachern Ship Company, of Astoria, Ore. The company claimed $6,259,414.92 for the cancellation of contracts 96 and 330, calling for wooden hulls. It was allowed $5,415,212.92.

BUYS NEW YORK HOME

Shipping Board Gets Hamburg-American Building

The United States Shipping Board has bought the Hamburg-American building, No. 45 Broadway, New York, for $2,000,000, from the Atlas Steamship Line, the stock of which is held by the Alien Property Custodian.

Three floors of the structure, which is an 11-story building, will be occupied by the army for about six months, after which they will be taken over by the Board. Departments of the Shipping Board which will have offices in the building are those of operations, treasurer, repair and part of the accounting force.

More Contracts for Downey

The Downey Shipbuilding Corporation closed contracts a few days ago with the Southern Pacific Company to build three 12-knot steel steamships, length over all 352 feet, molded beam 47 feet, molded depth to hurricane deck 32 feet 6 inches, mean loaded draft 23 feet. Propelling machinery will be triple expansion reciprocating steam engines, Scotch boilers, oil burning. The auxiliary and general equipment of these three steamships will be of the highest class, in accordance with the practice of the company.

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69 NEW STEAMERS FOR NIPPON YUSEN KAISHA

Japan's Premier Company Will Add 515,000 Tons to Its Fleet,—High Speed Passenger Boats Part of Programme—Will Compete for Trans-Pacific Trade.

Recently announced developments show that Japanese shipping interests are entering seriously on the task of obtaining a large share of the world's carrying trade. The after-war programme of the Nippon Yusen Kaisha shows that the big Japanese steamship company plans to add 515,000 tons of new shipping to its already large fleet, which will increase the total to more than 1,000,000 tons. Of the 69 ships to be built 36, aggregating 382,000 tons, will be used in foreign trade and the remainder for coasting and China business.

The estimated cost, $110,000,000, will be obtained from the company's reserve fund and the sale of some of its obsolete vessels, and the programme will carry shipbuilding work forward into 1925.

One feature of the projected addition to the fleet is a group of high-speed passenger vessels of 18,000 deadweight tons, with not less than 19 knots speed, three of which will be put on the transpacific line with the intention of challenging the fast service of the Canadian Pacific from Vancouver to Yokohama. The Canadian Pacific at present makes the trip in nine days, and the new Japanese ships are intended to make trips to a United States port instead of the British Columbia terminal in the same time.

Japanese officials who were sent to Europe and America several months ago to study shipping questions and prospects are expected to make a report which will result in a new shipping subsidy bill which will give Government assistance to new lines which were opened during the war. This will result in placing subsidized tonnage on many routes where it has not hitherto been seen.

Details of the Nippon Yusen Kaisha programme follow:

	Vessels
Oversea Traders—	
(a) Superior high-speed passenger vessels	6
(b) High-speed cargo vessels, 12,000 tons	5
(c) 10,000-ton type cargo vessels	18
(d) 8,000-ton type cargo vessels	2
(e) 6,000-ton type cargo vessels	5
Total (382,000 tons)	36
Coasting Traders—	
(f) High-speed passenger vessels	2
(g) 2-3,500-ton type intermediate vessels	13
(h) 5,000-ton type cargo vessels	10
3,000-ton type cargo vessels	7
Total (133,000 tons)	33
Grand total (515,000 tons d.)	69

(a) Out of the six, three are intended for the Pacific service, each being superior high-speed passenger vessels of 18,000 tons gross and 19 knots; the other three are for the European service in place of the steamers lost by submarines, viz.: *Yasaka Maru*, *Mizumaki Maru* and the *Hirano Maru*, and they will be of the *Katori Maru* type. (b) All five are to be placed on the West Coast of America service. They will be 12,000 tons deadweight, and they will have a speed of 14 knots. (f) Two of this type are of 5,000 tons each, and are intended for the Shanghai-Japan service.

NEW SHIPYARD EXPECTED

American Bridge Company Looking for a Delaware River Site

WILMINGTON, DEL., Dec. 30—[Special].—From an authentic source it is learned that the American Bridge Company is looking for a site along the Delaware River to fill a contract for the construction of a special class of boats. A representative of this company was in this city recently and talked with a number of owners of river front property, the company not looking to purchase a property, but, rather, to effect a long-term lease. Sites in this city and Eddystone have been recommended, among them the Pennsylvania Iron Works plant in Eddystone, and the unused part of the Chester Tube Company.

The statement is made that the enterprise will give employment to several thousand persons for at least a year on contracts already on hand, and before that time is up others are expected, which will mean a permanent plant, adding much to the industrial hive along the river. It is understood that the boats to be built are of the type of canal craft, similar to lighters used for heavy transportation.

An effort was made to confirm the rumor at the Edge Moor plant of the American Bridge Company, but without success. For some time it has been reported that another shipyard was in prospect along the Delaware River between Chester and Wilmington, but whether the present rumor has any connection with this is not known.

American Line Gets Two

Two of the former German passenger vessels, the *America* and the *George Washington*, have been allocated to the American Line of the International Mercantile Marine. Both are to be run between New York and Southampton via Brest and Cherbourg.

Neither vessel has as yet been turned back to the Shiping Board by the War Department. Both have been in the transport service between this country and France. It is expected that it will be considerable time before they can be reconditioned for service. The *America* has a deadweight tonnage of 21,810 and the *George Washington*, 13,300.

HAS LAUNCHED 102 SHIPS

Submarine Boat Co. Claims World's Record

Claiming that it made a new world's ship building record, the Submarine Boat Corporation launched three ships, the *Haslehurst*, the *Tashmoo* and the *Suwied*, at its Newark, N. J., yards on Saturday last. These bring the number of ships launched for the Shipping Board at the yard to 102 since its opening on Memorial Day, 1918. The total of deadweight tons is 545,700.

"No yard in the history of modern shipbuilding has even approached this record," said Henry R. Sutphen, vice-president of the company.

The *Haslehurst* was named for Henry Haslehurst Carse, son of Henry R. Carse, president of the corporation. Mrs. H. R. Carse was sponsor. Mrs. Charles Lanier, 2d, sister-in-law of R. B. Lanier, a director of the corporation, named the *Tashmoo*. The *Suwied* had a sponsor Mrs. Charles H. Hampton, wife of a vice-president of the Hanover National Bank, of which Henry R. Carse was once president.

Many New York people were in the crowd that attended the launching. On each of the ships was a phonograph with three records, one in English, one French and one Spanish, telling the history of fabricated ships.

BAYLES SHIPYARD SOLD

Arthur Allen Pays $2,225,500 for Port Jefferson Plant

The Bayles Shipyard, at Port Jefferson, L. I., has been sold by the Emergency Fleet Corporation for $2,225,500 to Arthur Allen, who has been connected with the Shipping Board for some time as assistant to Robert L. Hague. He has not indicated what disposition will be made of the vessels now building at the yard, four 5,000-ton deadweight cargo carriers, or the use to which the plant will be put in the future.

The ships being constructed at Port Jefferson are practically the same as those being produced at the Newark yards of the Submarine Boat Corporation, except that the Bayles ships will have reciprocating engines, while the Submarine Boat types are being equipped with turbines. The Port Jefferson yards have an area of about 7½ acres with four launching ways.

Will Sell Machine Tools

The War Department has entered into a contract by which the French Government is permitted to purchase $25,000,000 worth of machine tools from the surplus stocks of such tools held by the War Department in the United States. The French Government is to pay for such tools as it may purchase in ten-year 5 percent bonds of the French Republic, which at maturity are payable in dollars in gold coin of the United States.

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"GET-TOGETHER" PLAN HELPS BIG SHIPYARD AND ITS MEN

Harlan Plant at Wilmington, Del., Reduces Costs and Speeds Up Production Through Co-operation—Result, Work Ahead for Next Two Years

Wilmington, Del., Dec. 23 (Special).—The conservation campaign which was recently instituted by E. B. Germain, general manager of the Harlan plant of the Bethlehem Shipbuilding Corporation, to reduce the overhead cost of building ships and give faithful employes of the plant an incentive to increase the output of the yard and make it a standard bearer for the industry in the United States, has been a wonderful success.

This plan was put up to the men as something that meant not only their individual jobs, but also meant whether the company was to be able to continue in business. At the signing of the armistice, the Harlan plant had the highest cost production of any plant in the country, and in the little over twelve months intervening that expense has been reduced, until to-day it is the lowest in the United States as regards the cost of production per vessel. This has meant the obtaining of contracts which will employ the plant at top capacity for 1920, and assured contracts which will mean work for all during 1921, with others in sight.

During the war the plant employed about 7,000, and this has been reduced until now there are about 4,300 workers, turning out practically the same amount of work in a much better manner, the output being in every way shipworthy and able to pass the severest tests of the Government. This has meant the elimination of many "ribbon clerk" and "work or fight" employes, who entered the yard to escape war duty in the trenches when the "work or fight" order was issued.

Slackers have no place in the yard now, and this is due to the efforts of Mr. Germain and his staff of supervisory heads. The feat was accomplished by impressing on the men that capacity output meant the life of the corporation—their jobs and their family's welfare—and was brought about without a single change in the superintendents and foremen, other than the few who resigned of their own accord.

Through the weekly paper of the plant, the *Harlan News*, and weekly meetings of the foremen and superintendents with Mr. Germain and the executive officers, the fact was brought home to the men that the costs must be brought down. Facts and figures were produced which brought home to the men themselves just what the corporation was up against, and soon the men saw that unless the slackers were weeded out something drastic was likely to happen.

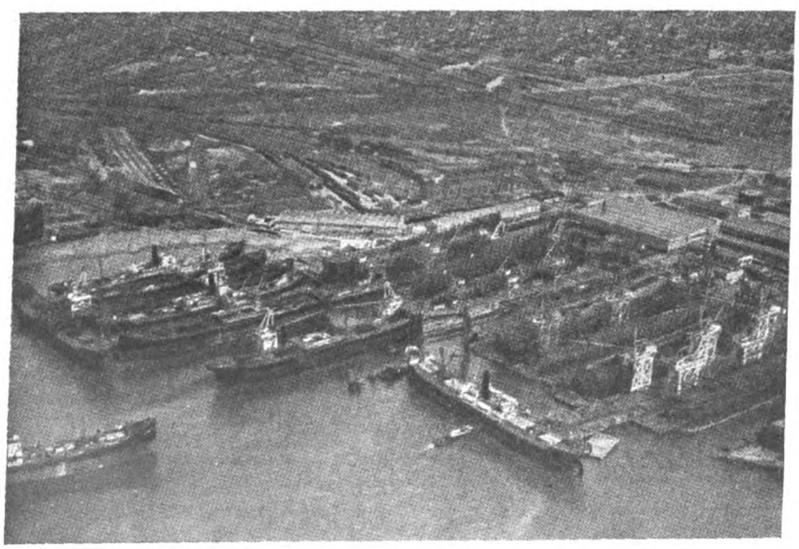
The fact that a loafer on the job was more the business of the man who was willing to work than of the boss, and should be gotten rid of before his idea permeated the entire staff and caused a shutdown, caused the real workers to join with the management in cleansing the plant of such ilk. This was accomplished, in a manner, through a cutting down of the late list and a suspension of "holidays," which were almost a matter of necessity, it appears, to a large percentage of the force. Wet weather suspension was also done away with completely. Attendance charts were drawn up, and in a final solution, only those men who appeared for duty every day are now working.

The showing of the plant has made it a fact that the local management has been assured of contracts for the construction of two 10,000-ton tankers for the Sinclair Oil Company, of Pittsburgh, and of a share in the construction of eight 8,500-ton tankers for an English firm, a representative of which is now on the way to this country to sign contracts with the Bethlehem Corporation. The men and officers of the local plant have been assured of a proportionate share of these contracts as a reward for the manner in which the cost production price has been cut down.

The foremen, since the inception of the campaign, meet every day at lunch with Mr. Germain and the superintendents and executive officers, where troubles and puzzles in the work are talked over, and views of all obtained when a particular perplexing question arises. This has been found one of the best means of showing in which way to decrease cost of production.

There is no labor unrest at the plant and never has been. Every man is willing and ready, and, in fact, anxious, to give his full 8-hours time for the money which he has been receiving for months past. Bolsheviki and I. W. W. radicals and such like are an unknown quantity in this happy family.

The whole scheme has been figured down to this: "Our business is your occupation. Do you want your job? If so, help us to lower the production cost so that we can bid successfully with other great shipbuilding firms of the country. If not, then let's close down, for we can't operate on wind."



Yard of Moore Shipbuilding Co., Oakland, Cal., Where Six Vessels Were Launched on One Tide, Saturday, Dec. 20, 1919, Making a World's Record.

NEW KERR S. S. OFFICES

One in San Francisco and One on Jan. 1, In Galveston

Some significance is attached to the announcement by the Kerr Steamship Co. that offices have been opened in San Francisco, as it is in line with its purpose to develop its transcontinental service, and this may mean that the company will enter the Pacific trade from Pacific ports. The San Francisco office will be in charge of Victor M. Smith, formerly general freight agent of the company in this city. He is now Pacific Coast manager for the company.

Simultaneously with the announcement of the opening of the San Francisco offices came the news of a Kerr Steamship Company office at Galveston, to be opened on January 1. From this new headquarters the Kerr interests radiating from Galveston and other Texan ports will be looked after by Thomas Rice, who will have charge at Galveston. Mr. Rice is well known in shipping circles in the Gulf region, having for some time managed the Port Arthur and Mobile offices of several large shipping companies.

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BIG CHRISTMAS BONUSES BY STEAMSHIP COMPANIES

Liberality in Rewarding Employees Reflects Prosperity During 1919—Kerr Line Plans Profit-Sharing—Green Star Has Big Expectations

That the large steamship companies of New York were prosperous during the year just ended was shown plainly by the extent of the bonuses and annual rewards paid to their employees Christmas. Practically all the steamship lines took part in the distribution in some form or other, and the extent of the gifts gave rise to the rumor that they were in some measure due to the decision that the employees might as well have the money as for the companies to turn it over to the collector of the excess income tax.

Executives of the larger concerns, who directed the movements of ships and governed the affairs of the companies, in some cases received as much as 100 percent of their salaries, but generally the bonuses ranged from 10 percent upward, the bonuses being based on a discriminative plan, taking into account the length of service, results obtained and the value of the office. No estimate has been made of the amount distributed, as the action was, of course, confidential, but it is a safe assumption that New York shipping circles never before have had such a Christmas.

Employees of the subsidiaries of the Atlantic, Gulf & West Indies Steamship Line were made happy when the presidents of the respective companies—the New York & Porto Rico Steamship Company, the Clyde-Mallory Steamship Company, the New York & Cuba Mail Steamship Company, the Southern Steamship Company, and the Atlantic, York & West Indies Line—informed them that the company had ordered distributed a bonus ranging from 10 to 50 percent.

The Kerr Steamship Company announced that it had put a profit-sharing plan into operation on Christmas Eve. The bonuses ranged from 10 percent upward. Some of the executives, who have been with the company for a long time and who have rendered especially valuable services, received gifts that exceeded 50 percent of their annual salaries.

The employees of the Green Star Steamship Company received a bonus of from 15 to 30 percent of their salaries. In making the announcement, H. H. Benedict, traffic manager, said: "By the time another holiday season rolls around the Green Star Corporation will no doubt be operating more steamers than any other concern flying the American flag."

The Luckenbach Steamship Company is reported to have declared a 50 percent bonus to its employees.

It was learned that Furness, Withy & Company authorized a melon-cutting with its many employees, but the percentage or the total amount of the Christmas bonus was not announced.

The Barber Steamship Company declared a bonus that ranged from 10 percent upward, and the award caused a lot of good feeling among the workers in the offices.

Neither the Cunard Line nor the International Mercantile Marine Company authorized a bonus or a sharing of profits at this time. It is understood to be the policy of the International Mercantile Marine to pay salaries that are commensurate with the value of the services performed, rather than distribute the profits in the form of bonuses. It claims to pay the biggest salaries of any steamship company in this country. The Cunard Line during the past few years has generally shared its profits in November and May.

INTENDS TO SPREAD OUT

National Motor Boat Show to Exhibit Heavy Machinery

The 1920 National Motor Boat, Ship and Engine Show will be held in Grand Central Palace, New York City, opening Friday, February 20, and closing Saturday, February 28.

Many exhibitors in the Motor Boat Shows of past years have shown only some of the proportionately smaller work that their particular yards or plants were capable of turning out. The influence brought to bear upon the industry by the necessities of war-time production, the commercial work that has been so successfully handled by many builders and manufacturers, and the unlimited possibilities that this newer and larger work have opened up for the boat building industry and its affiliated lines—all of these have been duly noted.

It has therefore been decided that, at the coming Show, exhibitors are to be given an opportunity to show the public not only pleasure boats and their equipment, but also some of the larger work that they are doing. Builders of the largest types of vessels will be encouraged to make such exhibits as the limitations of exhibit space may permit. Larger propulsion machinery, marine hardware and accessories will be shown by the manufacturers who have heretofore confined themselves to an exhibit of only that part of their output applicable to pleasure boat construction.

John J. Amory, of the National Association of Engine and Boat Manufacturers, Inc., is chairman of the exhibition committee.

G. A. FULLER CO. TO BUILD

Takes Over the Carolina Plant, at Wilmington, N. C.

The Carolina Ship Building Corporation's plant at Wilmington, N. C., has been purchased by the George A. Fuller Company, which began operation of the plant on January 1. The shipbuilding corporation was a subsidiary of the Fuller Company, incorporated for the purpose of executing a contract for the construction of the plant and of twelve 9,600 deadweight ton cargo steamers, equipped with reciprocating engines. Under the new arrangement the Fuller Company will complete eight of the twelve ships named in the contract for the Emergency Fleet Corporation for a lump sum price, and will build the remaining four of the ships for its own account and for sale. The plant is on the Cape Fear river, on fresh water within three miles of the city of Wilmington. There are four concrete ship ways, each 450 feet long, and the plant is complete except for facilities for the building of engines and boilers.

This is the first of the United States Shipping Board's yards to be sold to private interests, and it is believed that the venture of the Fuller Company into the shipbuilding industry will be of widespread interest. Paul Starrett is president of the company, and the officers in charge of the shipbuilding work will be: Lorenzo C. Dilks, vice-president; Ralph Starrett, works manager; Henry Vogt, assistant secretary and treasurer; J. R. Preston, technical manager; E. G. Glass, supply manager.

UNITED FRUIT TO RESUME

Eleven Special West Indian Cruises Arranged

Plans have been completed for the resumption of passenger service of the United Fruit Company. For the first time in five years tourists who have made the Caribbean their winter objective are eagerly making reservations for the series of eleven special cruises that will be begun early next month.

To win even more distinction for its famous Great White Fleet, the United Fruit Company announces that two new vessels will make their maiden cruises in conjunction with the steamers *Calamares* and *Pastores*. The new steamers are palatially fitted, and a private bath has been added to every stateroom, a feature to be found in no other vessels in the world.

Built by Workman, Clark & Company at Belfast, and named the *Ulua* and *Toloa*, the new steamers will partly replace the tonnage lost during the war. Because of their staunchness and adaptability the *Pastores* and *Calamares* were requisitioned for transport service in the early days of the war.

These vessels have all been overhauled by the Robins Dry Dock & Repair Company.

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BUSINESS NOTES

H. W. Philbrook, formerly with the General Electric Company, Schenectady, N. Y., has been appointed district manager of the Schutte & Koerting Company's New York office, 50 Church street, New York.

Earl E. Eby, sales manager of the Hyatt Roller Bearing Company in the Industrial Bearings Division, has been appointed one of the directors on the board of Hyatt, Ltd., a new company formed to market the Hyatt bearing in Europe. Mr. Eby's office will be located in New York.

G. O. Helmstadster, formerly Chicago district manager of the Hyatt Roller Bearing Company, has been made sales manager of the company as a result of the vacancy formed in this department by the new position assumed by Earl E. Eby.

The Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill., announces the location of its new office at Birmingham, Ala., at 1926 Fifth avenue, North.

The Jacobson Engineering Company, Inc., Albany, N. Y., at opened an office at 30 Church street, New York. This will be the main sales office for both domestic and export business. This company is the sole agent for the Jacobson Crude Oil engine built by the Jacobson Gas Engine Company, Albany, N. Y., also direct factory representative for builders of gas engines, gas producers, Diesel engines and all kinds of automotive machinery.

On January 1 the sales and contracting business formerly carried on by the General Fire Extinguisher Company was taken over by a new concern—Grinnell Company, Inc. The change was made because the old name so specifically described the automatic fire protection section of the company's business that it prevented the understanding on the part of the public that the company's business is based fundamentally on industrial piping, and that it is perhaps the largest concern in the United States doing exclusively that sort of work. The Grinnell Company offers a complete engineering and construction service in the whole field of industrial piping, including sprinkler, heating, power and drying work, and prompt sales service in material for all such equipments. In certain sections of the country this sales business has been expanded to include mill and plumbers' supplies. The executive offices of the company are 275-301 West Exchange street, Providence, R. I.

The Reading Iron Company, Reading, Pa., has acquired the plant of the E. & G. Brooke Iron Company, at Birdsboro, Pa. This acquisition adds to the already extensive equipment of the Reading Company 16 double puddling furnaces, with a three-high double muck mill, 24-inch three-high skelp mill with four heating furnaces, and a nail factory of 75 nail machines—the latter long known as one of the landmarks of the Eastern Pennsylvania iron industry. Through this addition to its manufacturing facilities, the Reading Iron Company's skelp capacity is increased by 2,800 tons per month, with a corresponding increase in the production of finished wrought iron pipe. The company is undergoing reorganization under the direction of L. E. Thomas, who succeeded F. C. Smink as president.

Frank O. Wells, president of the Greenfield Tap and Die Corporation, and one of the prominent figures in the screw thread industry in the United States, has sold his entire holdings to Frederick H. Payne, vice-president. Mr. Wells retires as president and member of the board of directors, and Mr. Payne has been elected president in his place. F. G. Echols, vice-president and general manager, has been elected as director to fill the vacancy caused by the resignation of Mr. Wells, who will remain with the corporation in an advisory capacity.

The American Engineering Company announces the appointment of Mr. Fayette A. Cook as district representative, Marine Products, in the Great Lakes district. This company's marine products include steering gears, telemotors, windlasses, capstns, gypsies, winches, towing machines, and marine chandlery. Mr. Cook is qualified to discuss the application of any marine auxiliaries, as well as to handle all requirements for repair parts. He will be located in Cleveland, with offices at No. 1111 Citizens' Building.

The Rotary Scraper Co., Inc., has removed its offices to No. 39 Broadway, New York City.

Mr. Comly B. Shoemaker, Jr., has been appointed assistant superintendent of the Roe puddling department of the Reading Iron Company.

The American Balsa Company, 50 East 42d street, has added to its staff Dr. M. E. Pennington, formerly chief of the Food Research Laboratory of the U. S. Department of Agriculture. He will be manager of the research division of the Balsa Company.

The Van Dorn Electric Tool Co., of Cleveland, Ohio, has added to its plant a new four-story building, with 30,000 additional feet of floor space. The entire plant is given over to the manufacture of portable electric drills, reamers and grinders, the great demand for these tools resulting from the widespread recognition of their superiority over cumbersome and expensive methods required in handling material in the past. Wherever electric current is available the Portland Electric Tool "goes to the job." During the war an extensive use was made of the Portable drill in ship building, and one application was its suspension in a light "buggy" frame, being moved from place to place to counterbore rivet holes in ship plate.

The Hooven, Owens, Rentschler Company, of Hamilton, Ohio, have opened two new offices and made some changes in the personnel of their other offices. An office has been opened in Philadelphia at No. 2129 Land Title Building, with Mr. C. M. Becker, formerly with the R. D. Wood Company, as manager. Richmond, Va., has a new office, with Mr. E. H. Fairchild, formerly of the C. & G. Cooper Company, in charge. Henry E. Balsley, formerly with the American Bridge Company, has been placed in charge of the Chicago office. E. S. Cooley, formerly with the Fall River Shipbuilding Company, has been added to the New York office staff, and R. C. Holman, formerly with the General Electric Company, has been placed in charge of all blowing engines.

New York Shipbuilding Corporation Buys Yard

Announcement has been made that the New York Shipbuilding Corporation has arranged to purchase from the United States Shipping Board four concrete ways, comprising the South Yard, which was built by the company during the war for the Emergency Fleet Corporation. The yards were constructed at a cost of approximately $5,000,000, but no price is mentioned as being paid for the South Yard.

The New York Shipbuilding Corporation is building a fleet of sixteen combination cargo and passenger ships for the Emergency Fleet Corporation. Nine of these are of the 585-feet type, with a speed of 18 knots, and seven are of the 503-feet class.

OBITUARY

WILLIAM M. EVANS

William M. Evans, vice-president of the Alabama Dry Dock and Shipbuilding Company, the pioneer steel boat builder of Mobile, died December 25, at the hospital of the plant that he was connected with. Shortly before noon he was striken with heart trouble, and gradually grew weaker until the end.

Mr. Evans came to Mobile twenty-five years ago from Columbia, S. C., as an employee of the boiler shop of the Louisville and Nashville Railroad. He organized the Gulf City Boiler Works and built the Ruth, the first steel tugboat turned out at Mobile for the Texas Company. The boiler works was merged with the Alabama Dry Dock and Shipbuilding Company, and he was made vice-president of the company and all the steel work of the big ship plant was under his direction.

He is survived by his widow, Mrs. Mattie T. Morrison Evans; six children, his parents, three brothers, one sister, and other relatives. Mr. Evans was a member of Rescue Lodge, Knights of Pythias, Howard Lodge of Masons and Abba Temple, Mystic Shrine.

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Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIP CONTRACTS

The Downey Shipbuilding Corporation, New York City, has closed contracts with the Southern Pacific Company to build three 12-knot steel steamships, length over all 352 feet, molded beam 47 feet, molded depth to hurricane deck 32 feet 6 inches, mean loaded draft 23 feet. Propelling machinery will be triple expansion reciprocating steam engines, Scotch boilers, oil burning. The auxiliary and general equipment of these three steamships will be of the highest class, in accordance with the practice of the Southern Pacific Company.

The Staten Island Shipbuilding Company, Mariner's Harbor, Staten Island, N. Y., has received a contract from the Tidewater Oil Company for one steel tanker. The vessel will be about 2,000 tons deadweight, 228 feet 6 inches over all, 37 feet 6 inches beam, and 17 feet depth, forward shear 3 feet 9 inches, shear aft 1 foot 9 inches. Her engines are vertical inverted direct-acting, triple expansion, with cylinders with 15 by 24 by 48 inches, stroke 28 inches. Under working pressure of 180 pounds per square inch they will develop about 750 horsepower, giving a speed of 10½ knots. The company has also received a contract from the Galena Oil Company for one steel tanker. The vessel will be 4,000 tons deadweight, 304 feet over all, 294 feet between perpendiculars, 42½ feet beam, 26 feet deep, 19 feet to second deck. She will be equipped with triple expansion engines, with two Scotch boilers and have an estimated speed of 11½ knots.

Six Tankers, Bethlehem Shipbuilding Corp.—The Harlan plant of the Bethlehem Shipbuilding Corporation has been advised that the parent company has received tentative contracts for the construction of six tankers, two of 10,000 tons each and four of 8,500 tons each. The former are larger than any vessels previously built at the local plant, and are intended for the Sinclair Consolidated Oil Company. The second group are to fill an English contract.

Oil Carriers, Bath, Me.—At the mammoth plant of the Texas Steamship Company, which came to Bath five years ago, and where several bulk oil carriers of 10,000 tons have already been built, four more are under construction, in addition to many smaller craft, such as harbor boats, barges, scows and towboats, all for the company's own use.

Wooden Schooner, Bath, Me.—Percy & Small, Inc., Bath, Me., are building a wooden schooner in their yard, and are repairing two big schooners built by them, but sold during the war to the France & Canada Steamship Corporation.

Large Passenger Liner, Seattle, Wash.—Plans and specifications for what will be the largest and fastest passenger liner plying Pacific waters have been submitted to the shipbuilding concerns of the Coast by the Pacific Steamship Company, of Seattle, Wash., A. F. Haines, general manager. The liner now under contemplation will be nearly 600 feet in length over all, being 560 feet between perpendiculars, and the width will be slightly over 80 feet. Propelled by electric drive and 20,000-horsepower turbines, the contract will demand a sustained sea speed of 22 knots an hour. This will be the fastest electrically-driven steamship in the world, the speed of dreadnoughts of the New Mexico class being 1 knot less.

Three Tankers, Portland, Ore.—The G. M. Standifer Construction Company, Portland, Ore., has received a contract for three oil carriers for the Standard Oil Company of New Jersey.

Oil Tankers, Quincy, Mass.—The first keel on a contract for the Standard Transportation Company, of New York, calling for four 12,500-ton oil tankers, was laid at the Fore River yards at Quincy, Mass. A similar ship will be built for the Atlantic Gulf & West Indies Steamship Company. They will be equipped with quadruple expansion engines of 3,000 horsepower, which will be built at the same yards.

The Moore Shipbuilding Company, Oakland, Ore., has received a contract for three oil carriers for the Standard Oil Company of New Jersey.

The Moore Shipbuilding Company, Oakland, Calif., has received a contract for a 10,000-ton tanker for the Vacuum Oil Company of New Yor. The ship will be 425 feet long, 57 feet beam, with a capacity of 72,000 barrels of oil. She will have Scotch boilers and a triple-expansion engine, and the contract calls for delivery in June, 1921.

The Standard Shipbuilding Corporation, 15 Whitehall street, New York, has been awarded a contract to construct two special type combination fruit and passenger ships for the Cuyamel Fruit Company, of New Orleans. Delivery has been guaranteed for the last of next May and June, and construction will be begun immediately. The steamers will be 235 feet long, 34 foot beam and 15 feet deep, with a speed of 11 knots and accommodations for 30 passengers. It is considered probable that they will cost more than $500,000 each.

Gielow & Orr, yacht designers, have finished plans and are to place the contracts for the construction of a large steam yacht, to cost about $750,000, which will be owned by the president of the Dodge Bros. Automobile Company.

The Murnan Shipbuilding Corporation, Mobile, Ala., has received a contract for ten barges for the Government to be used at Muscle Shoals, near Florence, Ala.

Steel Steam Yacht Overhauled, Portland, Me.—The steel steam yacht Colonia, belonging to President George D. Dearborn, of the American-Hawaiian Steamship Company, has been hauled out on the marine railway for extensive repair, and will probably remain there all winter.

Robert Jacob, City Island, New York, it is announced, has received a contract from Vincent Astor for a yacht smaller than his yacht Noma, which he sold to Rodman Wanamaker. The new vessel will be only 150 feet long, and will be driven by a Winton heavy-oil engine of 700 horsepower.

Commercial Power Boats, Bay City, Mich.—The De Foe Boat & Motor Works Company, Bay City, Mich., is building several commercial power boats for use on the inland lakes of Mexico. One of these vessels is 68 feet long, 14 feet wide and capable of carrying passengers and cargo. The boats are being shipped in sections. They have engines of 35 to 85 horsepower, capable of producing a speed of ten miles an hour.

Lifeboats, Mobile, Ala.—The Mobile Steel Company, Mobile, Ala., which has just finished fourteen steel lifeboats for the International Shipbuilding Company, is building ten for the Alabama Shipbuilding Company, and twelve for the Federal Shipbuilding Company.

Four Submarines Purchased, New London, Conn.—T. A. Scott & Company, New London, Conn., submarine engineers and wreckers, have bought the destroyers, Reid, Flusser, Preston and Lamson from the United States Government. The vessels, which are at the Philadelphia navy yard, are to be brought to this city in a few days. They will have a thorough overhauling, which will include the installation of Diesel engines. The destroyers are all of the coal-burning type. It is understood that the Scott Company will sell the boats.

Concrete Oil Barges, Tampico, Tex.—So much success was met with the recent construction at Tampico, Tex., of a concrete oil barge for the Atlantic, Gulf & West Indies Steamship Company that other barges will be built as rapidly as possible. The keel of a second vessel of this kind has been laid. This barge was construcoted of volcanic ash, is 80 feet over all and has 20 feet beam, 6 feet depth, 10 watertight compartments and draft of 20 inches. It has a capacity of 111½ tons on 48 inches draft. The only wood employed in the barge is in the fenders. There is believed to be a big future for larger vessels of this sort in the oil carrying business.

The Pusey & Jones Company, Gloucester, N. J., according to a recent announcement by William G. Coxe, president of the company, has received contracts for the construction of four 8,500-ton tankers for the Anglo-Saxon Company of London. These boats will be duplicates of several built three years ago by the Harlan plant of the Bethlehem Shipbuilding Corporation for the Shell Line.

The American Bridge Company, Pittsburgh, Pa., has contracted to build a large number of 1,000 deadweight ton oil barges for the Standard Oil Company and other oil concerns.

Sailing Vessels, Portland, Me.—At the yard of the Russell Shipbuilding Company, Portland, Me., where four Ferris type steamers were constructed, plans are being made under the management of Frank A. Rumery to build a fleet of sailing vessels on the company's own account. The first one, the four-masted schooner Ida May, 875 gross tons, was recently launched.

Passenger Steamers and Cargo Carriers, Japan.—The Japan Mail Steamship Company (Nippon Yusen Kaisha) plans an extensive building programme, including seven or eight large passenger steamers and fifty to sixty cargo carriers, and has declared a 50 percent dividend, plus a 50 percent bonus.

Cargo Carrier, Bath (Me.) Iron Works—Early this year the keel will be stretched for a steel cargo carrier for Crowell & Thurlow,

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of Boston. This craft is to be a sister ship to the Felix Taussig, built at Newport News, Va., in 1915. She will be 410 feet long, 55 feet beam, 34.5 feet deep, and will displace between 13,000 and 14,000 tons, making her the largest ship, save those for the navy, ever built at this plant.

Two Steel Barges or Converted Schooner Barges, Tampico, Mexico.—The Philadelphia manager of the Atlantic Coast Shipbuilders' Association advises that a construction firm in Tampico, Mexico, is in the market for two steel barges or converted schooner barges, with cargo capacity of from 2,000 to 4,000 tons, for use between Tampico and Texas ports for bringing lumber down and carrying crude oil back. Details can be obtained from the association's Philadelphia office, in the Shubert building.

Coasting Vessels, Rochester, England.—Short Bros., of Rochester, England, it is announced, are to begin the construction of coasting vessels up to 1,500 tons to be equipped with oil engines. At present the firm is engaged in building ordinary motor boats and small rowing boats. The firm expects considerable work along the new line, and is arranging for the purchase of a large water frontage. During the war Short Bros. constructed many of the largest seaplanes used by the United States Government.

Tankers, Holland.—The Royal Dutch-Shell Transport group has purchased from the British Government oil tankers to the avlue of $50,000,000, according to announcement by Joseph Walker & Sons. The Dutch-Shell fleet has a capacity now of almost 1,000,000 tons, all of which is busy.

Steamers, Yarrow-on-Clyde, Scotland.—The Yarrow yard is building two steamers of 3,500 tons each and two small stern-wheel steamers for river use.

Coasting Steamers, Renfrew-on-Clyde, Scotland.—Two coasting steamers are on the ways at the Simons yard at Renfrew.

Passenger Steamer, Whiteinch-on-Clyde, Scotland.—A passenger steamer of 11,000 tons for the Antwerp Line is being constructed at Whiteinch by the Lloyd Royal Belge.

Ship Construction, France.—Nine mail boats totaling 97,000 gross tons, 84 cargo steamers totaling 262,000 tons, 115 tugs totaling 15,900 tons, 21 fishing boats with auxiliary motors totaling 5,870 tons, 16 sailing vessels totaling 4,420 tons, and 174 barges aggregating 119,000 tons, are on the ways in French yards for French companies.

Ten Cargo Vessels and Six Liners, France.—The French Minister of Marine, according to a Paris report, has agreed with the Commissioner of Marine Transport to build ten new cargo vessels of the Marie Louise type and six liners for the Indo-China Line in the Naval Arsenals. These vessels will not be completed before 1922. They have been assigned as follows: Cherbourg, five cargo steamers; Brest, three mail steamers; L'Orient, three mail steamers; Rochefort, five cargo steamers.

The New York Shipbuilding Corporation is building a fleet of sixteen combination cargo and passenger ships for the Emergency Fleet Corporation. Nine of these are of the 585-feet type, with a speed of 18 knots, and seven are of the 503-feet class.

The Crosby Navigation Company, Bath, Me., is to build at its plant in Richmond a four-masted wooden schooner for the E. S. Crosby Company, recently organized under the laws of Maine.

Schooner, South Portland, Me.—At the yard of the Cumberland Shipbuilding Company, South Portland, Me., work has begun on a four-masted schoner of 1,000 tons, which will be launched early in the spring. James C. Hamlen, of South Portland, president of the company has extensive business interests in the island of Martinique, and may build several good-sized schooners in this yards for his own use.

The Bethlehem Shipbuilding Corporation, Bethlehem, Pa., Joseph W. Powell, vice-president, announced on December 27, the awarding of four contracts to the Harlan plant in Wilmington, two for 8,500-ton tankers and two for 7,300-ton tankers, which is believed locally to be part of a large order received by the parent company from an English concern.

NEW SHIPYARDS AND SHIPYARD EXTENSIONS

Marine Repair Shop, Texas City, Tex.—The Gulf Marine Repair Works, Texas City, will build a marine repair shop at that port.

Wooden Shipbuilding Plant, Tacoma, Wash.—Barbare Bros., Tacoma, Wash., shipbuilders, have begun the construction of a modern wooden shipbuilding plant in preparation for an active construction programme. Their old yard will be used as a repair plant.

Shipyard Reorganization, Freeport, Me.—The Cushing Briggs Shipyard at Freeport, Me., has recently acquired possession of the Northeastern Shipbuilding & Transportation Company, and will build motor-driven oil-burning vessels of standardized type of from 1,600 to 2,000 tons each. Morris M. Whittaker is general manager of the company, which is chartered under the Maine laws, with a capital of $1,500,000.

Dry Dock and Repair Plant, Pensacola, Fla.—About May 1 next the Bruce Drydock Company, Pensacola, Fla., expect to have in operation a new 5,000-ton drydock and repair plant. The dock will have a maximum capacity of 6,000 tons, and will lift vessels 475 feet in length. The estimated cost of the dock will be $450,000. It is to be a five-section floating wood drydock, with ample capacity for handling Gulf shipping. It will be 480 feet in length over all, 94 feet beam, 78 feet 2 inches between wings, depth of pontoons 12 feet, and 18 feet over 3½ foot keel blocks. The dock was designed by James L. Crandall, consulting engineer, East Boston, Mass., and the construction contract has been sublet to the Aberthaw Construction Company, Boston, Mass.

Two 10,000-ton Floating Drydocks, Delaware.—Rumors are current of a project fostered by interests prominently connected with the Hurley administration of the Shipping Board, and supported by adequate financial backing, to purchase the two 10,000-ton floating drydocks of Emergency Fleet construction for use on the Delaware. These docks, it is understood, are now being bid for by rival New York capitalists. The docks are offered at something more than $800,000, and the terms require payment within eight years.

Shipyard Purchased, Milton, Fla.—M. M. Feishaum, of Pascagoula, Miss., recently purchased the Hoodless Shipyards at Milton, Fla. Three uncompleted three-masted schooners on the ways of the plant were sold with the yards.

Drydock and Marine Railway Purchased, Jacksonville, Fla.—The Merrill-Stevens Shipbuilding Corporation, Jacksonville, Fla., has recently purchased from the Emergency Fleet Corporation the five-section drydock and the marine railway which they have been constructing at Jacksonville. This will be put into commission soon and will be a big asset to their plant. The drydock will be able to accommodate vessels of 8,000 gross tonnage.

Shipyard Reorganization, Charleston, S. C.—All the property of the Valk & Murdoch Company at Charleston has been taken over by the Charleston Dry Dock & Machine Company, a corporation which was chartered by the State of Delaware a few months ago, with a capital of $2,500,000. The affairs of the original company, which was capitalized at $125,000, are being liquidated. W. R. Bonsal is president of the new company, while Charles R. Valk, president of the Valk & Murdoch Company, becomes vice-president. Charles V. Boykin is general manager. The Charleston Dry Dock & Machine Company now has an 8,000-ton drydock, a 1,500-ton marine railway, and boiler and machine shops capable of making any kind of repairs needed by vessels.

Concrete Foundation for Launching Ways, Bath, Me.—The Bath Iron Works, Ltd., which has for a number of years specialized in the building of torpedo boat destroyers, is planning for commercial work, and the biggest concrete foundation for launching ways in Maine is being built.

Shipyard, Port Jefferson, Long Island, N. Y.—The Bayles Shipyard, Port Jefferson, L. I., has been sold by the Emergency Fleet Corporation for $2,225,500 to Arthur Allen, who has been connected with Shipping Board for some time as assistant to Robert L. Hague.

Marine Railway, Mobile, Ala.—Frank Henderson, president of the Henderson Shipbuilding Company, Mobile, Ala., announces that his corporation intends building another marine railway at that port, the cost of which will approximate $300,000.

Shipyard Sale Confirmed, New York City, N. Y.—Federal Judge Julius M. Mayer has confirmed the sale of the plant and shipbuilding yard of the Eastern Shore Ship Building Company, 2 Rector street, New York, to John H. Smith, Salisbury, Md., for $31,000. The sale took place on October 16 at Sharptown, Md.

Shipyard, Norfolk, Va.—It is reported that the National Concrete Boat Company, 203 East City Hall avenue, Norfolk, Va., which has a small plant in that city, is to build a large shipyard for the construction of its type of concrete vessels. About $500,000 will be invested, in connection with the addition of a railway repair department to the present works. Arthur W. Duehl is this company's chief engineer, and Arthur D. Davis is president.

Shipyard Control Changed, Wilmington, N. C.—The Caroline Ship Building Corporation's plant at Wilmington, N. C., has been purchased by the George A. Fuller Company, which began operation of the plant on January 1. The shipbuilding corporation was a subsidiary of the Fuller Company, incorporated for the purpose of executing a contract for the construction of the plant and of twelve 9,600 deadweight ton cargo steamers, equipped with reciprocating engines. Under the new arrangement the Fuller Company will complete eight of the twelve ships named in the contract for the Emergency Fleet Corporation for a lump sum price, and will build the remaining four of the ships for its own account and for sale.

Shipyard Sale, Newark, N. J.—Announcement has been made that the New York Shipbuilding Corporation has arranged to purchase from the United States Shipping Board four concrete ways, comprising the South Yard, which was built by the company during the war for the Emergency Fleet Corporation. The yards were constructed at a cost of approximately $5,000,000, but no price is mentioned as being paid for the South Yard.

New Shipyard, Wilmington, Del.—From an authentic source it is learned that the American Bridge Company is looking for a site along the Delaware River to fill a contract for the construction of a special class of boats. A representative of this company was in Wilmington recently and talked with a number of owners of river front property, the company not looking to purchase a property, but, rather, to effect a long-term lease.

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HARBOR IMPROVEMENTS

Deepening Channel, Philadelphia, Pa.—The United States Engineers' Department will ask bids for dredging in Philadelphia harbor to the depth of 35 feet. The work will begin in the vicinity of Pier No. 98, south, and extend up the river as far as funds will permit. The sum to be expended will amount to over $400,000.

Sea Wall, Corpus Christi, Tex.—C. J. Howard, city engineer, and Robert J. Cummings, consulting engineer, Houston, Texas, have completed surveys and presented a preliminary plan for building a sea wall into the bay at Corpus Christi. The cost is estimated at $2,900,000, the wall to be built in seven sections. A length of 600 feet is proposed, and the wall is to be twelve feet high, with an embankment rising two feet higher.

Deepening Channel, Newark, N. J.—There is a movement on foot to have the channel at Newark, N. J., deepened. While plans have been completed by ship designers for the large types of cargo carriers, it is said that no work will be started on the huge ships until the waters are sufficiently deep to permit launchings without trouble.

Eight Piers, Stapleton, S. I., N. Y.—The Commissioners of the Sinking Fund of the City of New York have adopted a resolution recommending to the Board of Estimate that the Controller be authorized to issue corporate stock of the city to the amount of $8,543,089 for the construction of eight piers at Stapleton, S. I.

$2,000,000 Pier, Portland, Me.—No decision has been made as yet by the commissioners having the matter in charge as to the site for the new State pier which is to be built at this port during 1920, at an expense of $2,000,000, but Chairman Henry F. Merrill stated that ground will be broken early in April.

New Wharves and Dredging, Tunis and Sfax.—Beginning early this year the long-delayed improvements at Tunis and Sfax will be begun, the former calling for the prolongation of the phosphate wharves, the construction of a special wharf for coal imports, the dredging of both the sailing vessel and the principal harbors, and the equipment of the docks with the most modern means for handling cargo. The improvements at Sfax will consist mainly of enlargement of the phosphate wharves.

Warehouse and Terminal, Mobile, Ala.—The city commission of Mobile has passed a resolution offering to the United States Railroad Commission one of the sand islands at the mouth of Mobile River, off Choctaw point, as a site for the proposed $800,000 coal storage warehouse and terminal which operators of the Birmingham mineral district are urging the administration to construct here.

New Piers, New York City, N. Y.— Murray Hurlbert, Commissioner of Docks and Director of the Port of New York, recently announced that the War Department has given its consent to an extension of the pier head line of the Hudson River from Pier 11 south to the Battery, which will permit the construction of a number of new modern piers.

Dock Bonds, Pensacola, Fla.—Pensacola's City Commissioners have passed the ordinance authorizing the issuance of $400,000 dock and belt line railroad bonds. It is now stated that the work will go ahead promptly, and Pensacola will soon have an up-to-date municipal wharf.

Harbor Improvements, Auckland, N. Z.—The Harbor Board of Auckland, N. Z., has obtained permission from Parliament to borrow $4,886,500 at not to exceed 5½ percent interest for harbor improvements, which will include a breakwater, wharf construction, equipment, warehouse, tide deflector, ferry wharf and reclamation work.

Port Improvements, London, England.—The London Road Board is vigorously urging the creation of a new authority to prepare a comprehensive planning scheme for the whole of the London dock and riverside area. An English writer recently declared that after visiting a large proportion of the big ports throughout the world he could safely say that London took first place in colossal inefficiency.

Port Improvements, La Pallice, France.—Improvements at the port of La Pallice, in the Rochelle district of France, have been going on steadily recently. The port is the most important one in the district for large cargo steamers, owing to the fine facilities for handling freight.

Piers, Weehawken, N. J.—The Cunard and Scandinavian-American Steamship Companies plan to build several large three-decker piers adjoining the West Shore Railroad Terminal. They will be built of concrete and steel.

Piers, Jersey City, N. J.—The Lehigh Valley Railroad, 64 Broadway, New York City, plans to build two steel lifting piers on the waterfront at the foot of Jackson avenue. Estimated cost about $300,000.

Piers, Love Point, Md.—The Peninsular Ferry Company, 702 American building, Baltimore, plans to build a 1,300-foot timber pier. Estimated cost between $40,000 and $50,000. R. T. Ford is in charge.

Marine Ways, Mobile, Ala.—The Henderson Shipbuilding Company, foot of Eslava street, plans to build a marine railway. Estimated cost about $300,000.

Dredging, East River, New York.—The United States Engineers Office, 39 Whitehall street, has let a contract for removing rocks and dredging in East River, First District, to the Arundel Corporation, Philadelphia, Pa., for $687,350.

Removing Wreck, New York, N. Y.—The United States Engineers Office, War Department, Washington, D. C., has let the contract for removing the wrecked schooner Geneva Mertis to C. W. Johnston, Brooklyn, N. Y., for $2,100.

Dredging, Harbor Beach, Mich. — The United States Engineers Office, 337 Federal building, Detroit, Mich., has let contract for dredging the main entrance to the harbor to projected depths of 21 and 23 feet to M. Sullivan, 179 Iroquois street, Detroit, for about $120,000.

Tanks, Bayonne, N. J.—The Tidewater Oil Company, Constable Hook, plans to build 15 oil tanks at tidewater on New York Bay.

Quay Wall, Norfolk, Va.—Bids will be received until January 14 by the Bureau of Yards and Docks, Navy Department, Washington, D. C., for the building of uncreosoted bearings, batter piles and creosoted fender piles and chocks, etc. Specification No. 4,044.

Wharves, Bamfield, B. C.—The Department of Public Works, Ottawa, Can., is soon to let contracts for repairing wharves in Bamfield and Ucluelet, pile and timber construction. Estimated cost about $30,000. A. Lafhuer, Ottawa, is in charge.

Breakwater, Meteghan, N. S.—Bids will be received until January 21 by C. S. Desbrochers, Secretary of the Department of Public Works, Ottawa, for rebuilding an ell to the main breakwater.

Piers and Docks, Baltimore, Md.—The Spedden Shipbuilding Company and the Canton Lumber Company have let contracts for rebuilding timber and concrete piers and docks on Boston street at the foot of Kenwood avenue, to A. Miller, of 3122 Foster avenue. The total cost will exceed $250,000.

East Jetty, South Pass, New Orleans, La.—The United States Engineers Office Custom House, New Orleans, has let a contract for furnishing and placing 25,000 tons of stone and 5,000 cords of willow brush along the inner East Jetty at South Pass, Miss., to L. F Alexander, Audubon Place, New Orleans. Cost, $226,500.

SHIPPING DEVELOPMENTS

Twenty-seven Wooden Barges Purchased, Baltimore, Md.—It was announced recently that the sale of twenty-seven wood barges owned by the Shipping Board had been made to W. B. Duke and associates of Baltimore. The transaction involves approximately $1,458,000. The barges, of 2,500 tons each, were sold at $54,000 each. Terms were one-third of the total amount cash payment, one-third within six months, and the remaining one-third within twelve months.

Shipbuilding Company, New York.—The Atlantic Marine & Construction Company, has recently been incorporated with a capital of $2,000,000, to build boats. The incorporators are: Herbert S. Bain, C. S. Boech and J. Dowsany, all of New York.

Steamship Reorganization, New York.—Announcement has been made at the office of the Clyde Steamship Company that the company had acquired the steamship interests of Edward M. Raphel & Company and the Raporel Steamship Line. The Raporel Line will continue operation as heretofore, with its offices at 17 Battery Place.

Power Company, Newark, N. J.—A company under the title of the Stein International Power Company has been incorporated in New Jersey, with a capital of $500,000, with the announced intention of manufacturing wave power air compressors, apparatus and machinery. The offices of the company are at 790 Broad street, Newark, N. J.

Schooner Purchased, Providence, R. I.—The two-masted schooner A. G. Pease, recently hauled out and practically rebuilt on the East Providence drydock, has been sold to Manuel Court, of Providence, R. I., who will fit her out for a voyage to Brava, Cape Verde Islands. This is the second schooner Mr. Court has bought for the Brava trade within a year.

Merchant Vessel Sold, Argentina, S. A.—The first merchant vessel of any considerable tonnage ever built in Argentina has recently been sold by the builders, the Astilleros Escandinavo-Argentinos (Scandinavian-Argentina Shipping Yards), located on the Tigre river, a few miles from Buenos Aires. The yards of this company make the construction of much larger vessels practicable, and August Johnson, the president, has announced that the company will at once undertake operations on a larger scale.

GOVERNMENT SALES

Three Steam Propelled Vessels, New York City.—The Director of Sales announces that the Transportation Service of the Army is offering for sale under sealed proposals three steam propelled vessels, now in the port of New York, bids for which will be received by the Port and Zone Transportation Officer, 45 Broadway, New York City, until 10 o'clock A. M., January 15, 1920. The three vessels to be offered for sale are the wooden tug, Alpha, the wooden freight and passenger vessel, Bronx, and the wooden freighter, Long Island. Inspection of these vessels may be made by applying to the Officer in Charge of Vessels' Operations, Room 705, 45 Broadway, New York City. Further information regarding this sale may be obtained from the Port and Zone Transportation Officer, 45 Broadway, New York City.

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